United States of America, Northern District of Illinois, EASTERN DIVISION.

IN THE

District Court of the United States

UNITED STATES OF AMERICA Complainant,

THE SANITARY DISTRICT OF CHICAGO, Defendant, C. C. No. 29,019, and Equity No. 114.

RECORD OF TESTIMONY AND PROOF TAKEN BEFORE COMMISSIONERS APPOINTED TO TAKE TESTIMONY IN SAID CAUSE.

Appearances:

MR. JAMES H. WILKERSON, United States Attorney, and MR. ALBERT L. HOPKINS, Assistant United States Attorney, For Complainant.

MR. EDMUND D. ADCOCK and MR. ALFRED S. AUSTRIAN,

For Respondent.

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United States of America,
Northern District of Illinois,
Eastern Division.

ord.

IN THE

District Court of the United States

UNITED STATES OF AMERICA,
Complainant,

THE SANITARY DISTRICT OF CHICAGO,
Defendant.

C. C. No. 29.019.

STIPULATION.

It is hereby stipulated that the following matter may be considered in evidence with like effect as if witnesses were called and testimony were taken in this case, subject, however, to all objections as to materiality and competency:

1. Extracts from testimony and historical data in the case of United States v. Economy Light and Power Com-

pany, as set out in detail hereinafter.

2. Historical data from Brown's Drainage Canal Report, Report of the Illinois and Michigan Canal Commissioners for the year 1900; Andreas' History of Chicago, and extracts from Reports of United States Engineers, and certain other public documents, all as set out in detail hereinafter.

J. H. WILKERSON, United States Attorney.

EDMUND D. ADCOCK, Attorney for Sanitary District of Chicago.

Chicago, April 8, 1914.

UNITED STATES VS. SANITARY DISTRICT OF CHICAGO.

MEMORANDUM OF EXTRACTS TO BE READ IN EVIDENCE ON THE PART OF THE DEFENDANT, FROM THE CASE OF UNITED STATES VS. ECONOMY LIGHT AND POWER CO., IN THE UNITED STATES DISTRICT COURT.

CLARENCE W. ALVORD, a witness for complainant (United States), testified as follows:

I live in Urbana, Illinois. I am connected with the University of Illinois, my title being Associate Professor of History. I also have the position of special editor of publications of the Illinois State Historical Library. The Library is a department of the state engaged in the study of Illinois history. It collects volumes on Illinois history and publishes from time to time in its collections documents illustrating the history of the state. I have edited and published several articles and volumes for the Illinois State Historical Library. The first was a bulletin entitled "Illinois in the Eighteenth Century." Since that time I have prepared volume 2 of the Illinois Historical Collections, having a sub-title, "Virginia Series, Volume 1, Cahokia Records." With Professor Greene, my colleague at the University, I prepared Volume 4 of the Illinois Historical Collections, having the sub-title "Executive Series, Volume 1, Governor's Letter Books." And I also prepared myself Volume 5 of the Illinois Historical Collections with a sub-title, "Virginia Series Volume 2 Kaskaskia Records." For the Chicago Historical Society I published an essay called "The Old Kaskaskia Records," giving an account of the records which I discovered.

For the American Historical Association as adjunct member of the Public Archives Commission, I published a report on "The French Archives of Illinois"; and there is in the press today a report upon "The Archives in the State Capi-

In the Michigan Historical Collections, Volume 36, I published an essay entitled "The Genesis of the Proclamation of

In the proceedings of the Wisconsin Historical Society for 1908 I published an essay continuing the previous one entitled "The British Ministry and the Treaty of Fort Stanwix." For the Missouri State Historical Society I published an essay

entitled, "The Conquest of St. Joseph by the Spanish in 1780."

In the American Historical Review I published an essay with documents on "The Capture of Vincennes by George Rogers Clark, in 1788."

For the Club of Colonial Reprints, having its headquarters in Providence, Rhode Island, I published a pamphlet with introduction and notes, entitled "Invitation Serieuse aux Habi-

tants des Illinois, par un Habitant."

In connection with the preparation of these different publications to which I have referred, and these different manuscripts and articles, my study of the various historical data and materials and sources of compilations that relate to the early exploration and settlement of the Illinois country has been very extended. That is part of my business as editor of the Illinois Historical Collections. It is the intention of the trustees of that institution to publish in the course of time all available material, and it is my duty to inform them from time to time what material is available, and what it will be most feasible to publish, so I have been obliged to familiarize myself with the history of the state and the material upon which that history is based. As professor of history in the University of Illinois I have for years given a course to advanced students upon the history of Illinois. As professor in the graduate school, all of my courses for the doctor's degree have been in western history, taking in, of course the history of Illinois in a larger view.

One of the young doctors who took his degree at the University of Illinois recently wrote his thesis upon the history of Illinois under Great Britain, which thesis won the Justin Winsor prize of the American Historical Association, probably the most important prize offered for young writers in

history in America.

My present position as a specialist in Illinois history dates from early in the year 1905. In 1905 I was a general teacher in the department of history; part of my time was given to other fields, but since 1906 all of my attention has been given

to Illinois history and Western history.

I have made a special study of the early commerce of the Illinois country. Probably one of the most important contributions to the knowledge of the history of the west that I have made has been connected with the trade in the west. I have in my search for unprinted material found a mass of stuff, not only here in Illinois, but in Canada and in Boston and Albany and Philadelphia, bearing upon the trade of the

Illinois country in its early period, particularly the fur trade, the trade with the Indians. That material I have partially published, but a very large mass of it is still unpublished; but the originals or copies of the originals are in my possession, and in the course of the next three or four years I will publish that which I have already found.

(Father Marquette's trip up the Illinois and Des Plaines River to Chicago 1673.)

Taking up the historical references that I have found in this research which have a bearing upon the use of the Des Plaines river for commercial purposes, the first reference is to the book entitled "Travels and Explorations of the Jesuit Missionaries in New France, 1610 to 1791. The original French, Latin and Italian texts with English translations and notes; illustrated by portraits, maps and fac-similes. Edited by Reuben Gold Thwaites, Secretary of the State Historical Society of Wisconsin. Volume 59. Published at Cleveland in 1900." This is one volume of a set of books known as the Jesuit Relations, and the documents therein found are translated from French into English under the direction of Doctor Thwaites. Dr. Thwaites is Secretary of the State Historical Society of Wisconsin, and shares with Professor Turner, of whom I have previously spoken, the reputation of being one of the most important historians versed in western American history. I know his standing among historians in this country to be just what I have stated. He is the author of a great many works of high standing and also has edited a very large number of works. A few of the collections that are best known among historians are "Early Western Travels." The latter volumes of the Wisconsin Historical Society have been edited by him. He has edited Father Hennepin's narrative. He has written one of the volumes of the American Nation series under the general editorship of Professor Hart of Harvard. He is the author of the volume of the American History series which is generally used in our colleges as a text book for freshmen and sophomore classes known as "Colonial America." There are very few historians in America who have published as widely as Dr. Thwaites. Dr. Thwaites has been for a number of years now Secretary of the Wisconsin Historical Society, the general reputation of which I have already mentioned. That society contains the best collection of manuscripts preserved in the archives west of the Allegheny Mountains. Doctor Thwaites although not responsible for the collection of

all has been instrumental in adding very materially to the collection of the society since he became its secretary. He has put that collection in excellent order and made it accessible to students in a way that was not the case before he became secretary. In doing this he familiarized himself with the whole collection of the Wisconsin Historical Society, so that there are few men in America that are better versed in the printed and unprinted material of western American history than Dr. Thwaites. I refer to the portion of this volume 59 of Jesuit Relations containing the report of Father Marquette on the first voyage on the Mississippi made by a Frenchman. There is not only a translation but a reprint of the original report, and the translation of the Jesuit Relations contained such reports from their missionaries. To explain in full as to how this series of books was compiled, I would say the Jesuit order was one of the first religious orders to extend its missions to America, and its missionaries may be counted among the bravest and most faithful of those that sought to convert the Indians to Christianity in the early days. It was a rule of the Jesuit Order that every Jesuit report yearly to his immediate superior. Thus the missionaries in America reported directly to their superior at Quebec. This superior extracted from these letters what he thought available, sometimes even taking the whole letter, and made a similar report of all the activities in his district to his superior in Paris. The Jesuits were very anxious that the public should know of the work that they were doing in America, and every year they took these reports and printed a volume in Paris. These were known as the Jesuit Relations and continued to appear regularly for a number of years. The volumes of the Jesuit Relations are very scarce, and the individual volumes are quoted in our catalogues at very high prices. Doctor Thwaites therefore felt that there was call by historians for a new edition of these Jesuit Relations and he collected them and some other material bearing on the same subject and printed them with translations in seventy-three volumes. This is regarded as one of the great monuments of western scholarship. These reprints of the Jesuit Relations are regarded as having a very high character and being accurate, and are used exactly in the same way as the originals. Marquette, the writer of this letter, accompanied the expedition which was in command of Louis Joliet that made the first discovery by Frenchmen of the Mississippi river. The expedition occurred in 1673. Unfortunately on the return Louis Joliet lost the memorandum which he had kept, so that the best account we have of the

journey comes from the priest that accompanied him, Father Marquette. Father Marquette has enjoyed among contemporaries and by men who have since written about him, a most excellent reputation for religious zeal, capacity and accurate observation. Any statement of Marquette's in regard to a matter of fact of which he personally had knowledge would be regarded by historians as accurate and would be so used. The reason for their being so used by those who are engaged in the work of historical research is because of Marquette's character. The facts with reference to that are well known and well established. The letter to which I refer begins on page 87 of this volume and goes to page 163. The passage referred to here is found on pages 161 and 163.

"After a month's navigation, while descending Mississippi from the 42nd to the 34th degree, and beyond, and after preaching the Gospel as well as I could to the Nations that I met, we start on the 17th of July from the village of the Akensea to retrace our steps. We therefore reascended the Mississippi which gives us much trouble in breasting its currents. It is true that we leave it, at about the 38th degree, to enter another river, which greatly shortens our road, and takes us with but little ef-

fort to the lake of the Illinois.

We have seen nothing like this river that we enter as regards its fertility of soil, its prairies, and woods; its cattle, elk, deer, wildcats, bustards, swans, ducks, parroquets, and even beaver. There are many small lakes and rivers. That on which we sailed is wide and deep and still, for 65 leagues. In the spring and during part of the summer there is only one portage of half a league. We found on it a village of Illinois called Kaskasia, consisting of 74 cabins. They received us very well, and obliged me to promise that I would return to instruct them. One of the chiefs of this nation, with his young men escorted us to the Lake of the Illinois, whence, at last, at the end of September, we reached the bay des Puantz, from which we had started at the beginning of June."

(Prof. Alvord continuing):
The Lake of the Illinois which is there mentioned is Lake Michigan. The name given very frequently by old voyagers was the lake of Illinois, because at one time the Illinois Indians lived upon it. It afterwards was given the name of one of the tribes of the Illinois Confederacy, the Michiganies, and the route referred to is to the

use of the Desplaines and Chicago river, which was the water route that was followed by Marquette on a later voyage and by other Jesuits.

(Report of Father Dablon, 1673.)

I have before me a passage from 1 Margry, pages 267 and 268. "The relation of the new discovery of many countries situated to the south of New France, made in 1673," appearing in 58 Jesuit Relations, presents at page 105 a translation of the same passage that was translated by me from the same volume of Margry. This translation is by Thwaites. I have testified to the high character of his translations. The passage is as follows:

"The fourth remark concerns a very great and important advantage which perhaps will hardly be believed; it is that we could go with facility to Florida in a barque and by very easy navigation. It would only be necessary to make a canal by cutting through but half a league of prairie to pass from the foot of the lake of the Illinois to the River St. Louis. Here is the route that would be followed:

The bark would be built on Lake Erie, which is near Lake Ontario; it would easily pass from Lake Erie to Lake Huron, whence it would enter Lake Illinois. At the end of that lake the canal or excavation of which I have spoken would be made, to gain a passage into the River Saint Louis, which falls into the Mississippi. The Bark, when there, would easily sail to the Gulf of Mexico."

(Prof. Alvord continuing):

The next passage to which my attention is directed is in Volume 1 of Margry, page 523. This passage is taken from the same official account of the undertakings of LaSalle in the years 1679 to 1681. It refers to LaSalle's own use of a river route leading to Lake Michigan in pursuit of Tonty. I have translated the portion of that account which relates to this use of the river route, and the translation is correct. Said translation is as follows:

(LaSalle's use of DesPlaines River, January, 1861.)

"Finally he set out on the 28th with three canoes, twenty minots of Indian corn and his equipage which he and his men dragged over the snow, although the whole weighed more than 4000 pounds, and he arrived the 6th of January the year 1681 at the juncture of the river Divine with that of the Teatiki. He decided to follow

the first, because six leagues below he had found a cabin where he judged that Monsieur Tonty has passed, because, since he had not met him on the river Teatiki, he (Tonty) must have necessarily have followed the River Divine. The hope which he (LaSalle) had of joining him (Tonty) made him resolve to leave in this place at a distance from the usual trail of the savages all his merchandise, in order that he might make greater speed. He hid them as well as he could and left there Monsieur D'Autray who volunteered to guard them, together with the physician."
(Professor Alvord continuing): The word Teatiki refers

to the Kankakee river and "Divine" to the DesPlaines.

LASALLE'S USE OF RIVER, DECEMBER, 1682.

As to the book to which my attention is now drawn, which is described on its back as "Discovery and Exploration of the Mississippi," by Shea, Volume 4, I would say that John Gilmary Shea was a historian who devoted his attention particularly to the history of Roman Catholics in America. On account of his own religion he had opportunities to examine archives of the Roman Catholic bodies in Canada that were not given to Protestant investigators. The result is that Shea has been able to publish much material on western history that is non-accessible in other forms. His reputation as a historian is a most excellent one, and his translations are regarded by historians as accurate.

In this particular volume he took up the question as to the discoverer of the Mississippi River. Up until that time there had been a great many candidates for the honor of the first discovery. Since Shea wrote this volume there has been no question among historians that Joliet and Marquette were the first French to make the voyage down the Mississippi. This particular account is the "Narrative of LaSalle's Trip in 1682," by Father Membre, a Recollect Friar that accompanied him. The passage to which I refer is found on page 166 and is

as follows:

Discovery and Exploration of the Mississippi, Shea, Vol.

IV, p. 166:

"On the 21st of December, I embarked with the sieur de Tonty and a part of our people on Lake Dauphin (Michigan) to go toward the Divine River, called by the Indians Checagon, in order to make necessary arrangements for our voyage. The sieur de La Salle joined us there with the rest of his troop on the 4th of January, 1682, and found that Tonty had had sleighs made to put all on and carry it over the Chicago which was frozen; for though the winter in these parts is only two months

long, it is notwithstanding very severe.

We had to make a portage to enter the Illinois river, which we found also frozen; we made it on the 27th of the same month, and dragging our canoes, baggage and provisions, about eighty leagues on the river Seignelay (Illinois), which runs into the river Colbert (Mississippi), we traversed the great Illinois town without finding anyone there, the Indians having gone to winter thirty leagues lower down on Lake Pimiteoui (Peoria) where Fort Crevecoeur stands."

(Prof. Alvord continuing):

Basing my answer upon my study and examination of these different historical authorities I would say that the particular passage refers to the journey which LaSalle made in 1682, wherein he made his famous voyage down the Mississippi to the Gulf, and took possession of the country watered by the Mississippi and its tributaries in the name of the King of France.

JOUTEL'S USE OF RIVER, MARCH, 1688.

The first one to which I refer is the volume in my hand, "Joutel's Journal of LaSalle's Last Voyage, 1684-7. New Edition with Historical and Biographical Introduction, Annotations and Index by Henry Reed Stiles, A. M., M. D., Albany,

1906."

This is an edition in translation of Jontel's Journal of the voyage of M. LaSalle. LaSalle proceeded to put into execution his idea of making the Mississippi the channel of trade and obtained from the King of France a fleet with which he sailed for the mouth of the Mississippi river. On account of the ignorance of the exact location of that river the fleet reached the coast of what is now Texas, and on account of disputes between LaSalle and the admiral, the party was there left and LaSalle with his party attempted to make their way to the Mississippi by land. They experienced great hardships and finally LaSalle was murdered by his followers. Joutel became the leader of the party then and with them made his way to the Mississippi and up the Mississippi to the Illinois river where he was received by Tonty; and from there he proceeded to Canada. This is a publication in trans-

lation, as I said, of that journal kept by Joutel and is regarded as an accurate translation and one of known character.

I find on page 196 of this book a passage which throws light on the question of the use of this route, which passage is as

follows (Joutel's Journal, Stiles Edition, p. 196):

"We continued after this Manner, till the Month of December, when two Men arrived from Montreal. They came to give Notice to Monsr. Tonty, that three Canoes laden with Menchandise, Powder, Ball and other Things were arriv'd at Chicagou, that there being two little water in the River and what there was being frozen, they could come down no lower; so that it being requisite to send Men to fetch those Things. Monsr. Tonty desir'd the Chief of Chahouanous to furnish him with People. That Chief accordingly provided forty as well Men as Women, who set out with some French men. The Honesty of the Chahouanous was the Reason of preferring them before the Islinois who are naturally Knaves.

That Ammunition and the Merchandise were soon brought and very seasonably, the Fort being then in Want. We stay'd there till the End of February, 1688, at which Time we fix'd our Resolution to depart, tho' we had no News from Canada as we expected. We found there were some Canoes ready to undertake that Voyage, and we laid hold of that opportunity to convoy each other to the Micilimaquinay, where we hop'd to meet some News from

Canada.

Monsieur Cavelier the Priest, had taken Care before the Death of M. deLaSalle, his Brother, to get of him a Letter of Credit to receive either a Sum of Money or Furs in the Country of the Islinois. He tender'd that Letter to M. Tonty, who believing M. deLaSalle was still alive, made no Difficulty of giving him to the value of about 4000 Livres in Furs, Castors, and Otter Skins a Canoe and other Effects, for which, the said Monsr. Cavelier gave him his Note, and we prepar'd for our Journey.

I have before observed, that there was a Jesuit whose name was Dalouez at Fort Lewis, and who had been very much surpriz'd to hear that Monsr. de La Sale was to come in a short Time being under great Apprehensions on Account of a Conspiracy intended to have been carry'd on, against Monsr. de la Sal's Interest. That Father perceiving our Departure was fix'd, mov'd first and went away foremost, to return to Miciliamquinay; so that they

were left without a Priest at Fort Lewis, which was a great Trouble to us because we were the Occasion of it, and therefore those, who were to remain in the Fort, anticipated the Time, and made their Easter, taking advantage of the Presence of F. Anastasius and M. Cavalier.

At length we set out on the 21st of March, from Fort Lewis. The Sieur Boisrondet, who was desirous to return to France, join'd us, we imbark'd on the River, which was then become navigable, and before we had advanc'd five Leagues met with a rapid Stream, which oblig'd us to go Ashore, and then again into the Water, to draw along our Canoe. I had the Misfortune to hurt one of my Feet against a Rock that lay under Water, which troubled me very much for a long time; and we being under a Necessity of going often into the Water, I suffer'd extremely and more than I had done since our Departure from the Gulph of Mexico.

We arrived at Chicagou the 29th of March, and our first care was to go seek what we had conceal'd at our former Voyage, having, as was there said, bury'd our Luggage and Provisions. We found it had been open'd and some Furs and Linens taken away, almost all which belong'd to me. This had been done by a French Man, whom M. Tonty had sent from the Fort, during the Winter Season, to know whether there were any Canoes at Chicagou and whom he had directed to see whether any Body had medled with what we had conceal'd and he made Use of

that advice to rob us."

JOUTEL'S USE OF THE RIVER, MARCH, 1687.

(Prof. Alvord continuing):

The next book which is called to my attention is the 3rd volume of Margry, which contains the relation of Joutel, beginning at page 91. The particular passage which relates to the Des Plaines river is found on page 485. I have made a correct

translation of that passage, which is as follows:

"We continued to travel until Thursday the 25th (March, 1687) when we arrived at the place called Chicagou, which according to what we were tolld took its name from the quantity of garlic which grows in the woods in that region. There is there a little river which is formed of the waters that drain from a great prairie or field at this place, and which takes its course towards the

lake named, as I have said elsewhere, Illinois or Michigan. About three or four leagues away on the other side of the great prairie, the waters discharge into the Illinois river and form that. It seems that this place must be the highest between the Gulf of Mexico and St. Lawrence river, since the waters flow from that place in one and the other direction so that the higher they are the less distance must be portages, for in navigation of this kind, the canoe or boat must be carried, as well as the clothing; there is no way of escaping that task."

(Prof. Alvord continuing):

The sentence "We continued to travel until Thursday" refers to Jontel and Abbe Cavelier, a brother of LaSalle, on their return from the expedition to the mouth of the Mississippi. As I have said before, LaSalle was murdered after the party had landed on the coast of what is now Texas; and Joutel, with a brother of LaSalle, Abbe Cavelier, made their way up the Mississippi to Illinois and it is the account of the continuation of that journey.

CHAMPIGNY'S REPORT 1697.

The next book to which my attention is directed is entitled, "Collections and Researches made by the Michigan Pioneer and Historical Society, Volume XXXIII, Lansing, Michigan, 1904." This volume contains what is known as the Cadillac Papers. Cadillac was for some time the French Governor or French Commandant of Detroit, and was the founder of that post, in fact. His papers have been printed by the Michigan Pioneer and Historical Society in translation. The transcripts were made in Paris at the expense of Mr. C. M. Burton, a well known historian of the west, and under his general oversight these translations were made, which are regarded by historians as of character and accuracy. The particular report I refer to begins on page 72, signed Champigny, Quebec, October 13, 1697. Champigny was an intendant of Nouvelle, France, and is writing to his Majesty, Louis XIV of France. In a general way the nature of this report is a report concerning Tonty and de la Forest, who were the successors of La-Salle in the Illinois country, and who were carrying on trade there. Champigny writes concerning their enterprises. The particular passage is on page 75 and is as follows (33 Mich. Pioneer & Hist. Col., p. 75): "Paragraph 25. His Majesty has permitted the Sieurs

de Tonty and de la Forest to keep Fort St. Louis of the Illinois on condition that they do not trade in beaver skins there.

I can assure you my Lord, with absolute certainty, that they will not stay there, and in fact cannot stay there, except to trade in them; otherwise it will involve them in an expense which they will be unable to bear. Hence it must be expected and taken as beyond doubt that, if they are allowed to go and remain there with Frenchmen, they alone will carry on the trade with the savages in the distant countries with immense profits. It is also well to inform you, my Lord, that they have now a warehouse at Chicagou in the country of the Miamis and another at Missillimackinac and that they have sent boats to other places, two of which have been rifled by the Illinois savages when they wished to take them to the savages called Sioux who are the enemies of the others. And to show you in what hand and under whose command all the distant countries are, it is right to inform you that the Sr. de La Forest is in command at Missillimackinac; the Sr. de Tonty, owner with him of Fort St. Louis of the Illinois has gone to the country of the Assinibouelles savages which is a very distant tribe to the north, where there are beavers in abundance; the Sr. de Tonty half pay captain, his brother, is the one who left Montreal unknown to me at the beginning of September, to go and take command in the place of the Sr. de La Forest at Missillimackinac, and the Sr. de Liette, a subordinate officer of the troops, cousin of the Sieurs de Tonty, commands at the post of Chicagou, in the country of the Miamis. have but one and the same mind and but one interest, tending solely to trading."

Q. Point out the historical connection between the passage just read and the statements already introduced made by

LaSalle with reference to this route?

A. From the statements that have been read into the record it is evident that those men that were closely associated with LaSalle continued to make use of the Desplaines and the Chicago River route. Joutel and Cavelier on their return from the expedition to the south where LaSalle lost his life, returned by this route. The successors of LaSalle in the region of the Illinois country, Tonty, and de La Forest, were exploiting the fur trade, and for that purpose placed a post at Chicago in order to command the water route from that region to the Illinois River.

(Prof. Alvord continuing):

Speaking from the standpoint of the historian as to whether or not these passages have any bearing upon the solution of the controversy between LaSalle and Joliet, they would show that the river route in dispute was capable of being used by traders and was used by LaSalle's successor and associates.

ST. COSME'S TRIP.

The next historical author to which I refer is a volume by John G. Shea, whose work I have already characterized. It is entitled "Early Voyagers Up and Down the Mississippi by Cavelier, St. Cosme, Le Sueur, Gravier, and Guignas. With an Introduction, Notes and an Index." These are published in translation and these translations are regarded as of known

character and accuracy.

St. Cosme was a member of the society known as the Seminary of Foreign Missions. The Seminary of Foreign Missions was established a short time before this was written, in Paris, and a branch was located in Quebec, and the priests were very active in their missionary zeal. They became rivals of the Jesuits. In 1698 St. Cosme, with others, was sent by the Seminary of Foreign Mission into the west to establish mission posts. They went through the lakes and down into the Illinois River, going as far as Arkansas, and then St. Cosme returned and established in 1690 a mission at Cahokia. That document which is published by Mr. Shea in translation is a letter to the Bishop of Quebec by St. Cosme, containing an account of the journey that he had made from Quebec to their missionary field.

The passage in which the writer gives the account of passing through the water route leading from Lake Michigan into the Illinois River begins at page 54. In regard to the passage on page 51 to which my attention has been directed, Mr. Shea says in a note in regard to it (Shea's Early Voyages, p. 51):

"I do not find this name of Kipikawi, or Kipikuskwi elsewhere. The river is evidently that emptying into the Lake at Racine, and this route was up the Root river and then by a portage across to the Fox, or Pishtaka (Bestikwi) river, which they descended to the Illinois. The names in this memoir have suffered greatly in transcription, and the copyist seems to have been especially bothered by the 8, which he replaces by vv or w, and sometimes

by r and k. As a vowel it corresponds to the English oo

(French ou) as a consonant to w.

Joutel on his map gives the name of Petescouy to this river, and Charlevoix (Hist. de La Nouvelle France, Vol. III, p. 380) mentions it as the Pisticoui; it is now called the Fox or Pishtaka or Pistakee, and a lake on its course is also called Pistakee."

The account of the use of the Desplaines River above re-

ferred to, is as follows (p. 50):

"Some Indians had led us to suppose that we might ascend by this river, and that after making a portage of about nine leagues, we could descend by another river called Pistrui, which empties into the river of the Illinois about 25 or 30 leagues from Chikagou. We avoided this river which is about twenty leagues in length up to the portage. It passes through quite pleasant prairies but as there was no water in it we judged sagely to that there would not be in the Bestikwi and that instead of shortening our way we should have had to make nearly forty leagues of the way as a portage. This obliged us to take the route of Chicagu which is about 25 leagues from it. We remained five days at Kipikuskwi."

Page 54:

"On the 24th of October the wind having fallen we made our canoes come with all our baggage and perceiving that the waters were extremely low we made a cache on the shore and took only what was absolutely necessary for our voyage, reserving till spring to send for the rest, and we left in charge of it Brother Alexander, who consented to remain there with Father Pinet's man, and we started from Chicagw on the 29th and put up for the night about two leagues off in the little river which is then lost in the prairies. The next day we began the portage which is about three leagues long when the water is low, and only a quarter of a league in the spring, for you embark on a litle lake that empties into a branch of the river of the Illinois, and when the waters are low you have to make a portage to that branch. We made half our portage that day and we should have made some progress further, when we perceived that a little boy whom we had received from Mr. DeMuys having started on alone, although he had been told to wait, and had got lost without anyone paying attention to it, all hands being engaged. We were obliged to stop and look for him. All

set out, we fired several guns, but could not find him. It was a very unfortunate mishap, we were pressed by the season and the water being very low, we saw well that being obliged to carry our effects and our canoie, it would take us a great while to reach the Illinois. This made us part company, Mr. De Montigny, de Tonty and Davion continued the portage next day, and I with four other men returned to look for this littley boy and on my way back I met Father Pinet and Buinateau, who were going with two Frenchmen and one Indian to the Illinois.

I set out on the second of November in the afternoon. made the portage, and slept at the River of the Illinois: we went down the river to an Island. During the night we were surprised to see an inch of snow and the next day the river frozen in several places, yet we had to break the ice and drag the canoe, because there was no water; this forced us to leave our canoe and go in search of Mr. de Montigny whom we overtook next day, the fifth of the month, at Stag Island (Isle aux Cerfs). They had already made two leagues portage, and there were still four to make to Monjolly, which we made in three days and arrived on the 8th of the Month. From Isle a la Cache to Monjolly is the space of seven leagues. You must always make a portage there being no water in the river except in the spring. All along this river is very agreeable.

On leaving Monjolly we made about two leagues to another little portage of about a quarter of a league. As one of our men, named Carbonneau, had killed several turkeys and geese in the morning and a deer, we did well to give somewhat of a treat to our people and let them

rest for a day.

On the 10th we made the little portage and found half a league of water, and then two men towed the canoe for a league; the rest marched on land, each with his pack, and we embarked for the space of a league and a half and stopped for the night at a little portage, five or six arpens off.

On the 11th, after making the little portage we came to the River Tealike, which is the real river of the Illinois; that which we had descended being only a branch.

From Chicagve to the Fort they reckon thirty leagues. Here navigation begins, which continues uninterrupted to the Fort of the Permavevvi, where the Indians are now. We arrived there on the 19th of November."

FATHER GRAVIER'S TRIP, 1700.

(Prof. Alvord continuing):

Referring to page 101 of volume 65 of the Jesuit relations and allied documents, being one of the series of books concerning the preparation of which I have already testified. I find an extract which refers to this river route. This is the "relation or journal of the voyage of Father Gravier of the Society of Jesus, in 1700, from the country of the Illinois to the mouth of the Mississippi river. Written to Father de Lamberville and sent from Fort Mississippi, 17 leagues from its discharge into the Mexican Gulf or sea, on the 16th of February, 1701." Father Gravier, as the record shows, was a Jesuit and one of the successors of Father Marquette in the Illinois mission. This particular relation is a very famous one in Illinois' history because it was on this journey of Father Gravier that he found the Kaskaskia Indians on the point of moving south at the solicitation of the commander of the French at the mouth of the Mississippi river, because LaSalle's proposed colony had already been founded, and those that were pushing it were in the hopes of moving the Indians to that region for the assistance of the fur trade and also for the protection of French posts. The beginning of the letter reads as follows:

"My Reverend Father, Pax Christie.

I received on my return from Michilimachinack the letters that you did me the honor of writing to me by way of the Mississippy, addressed to Father Aveneau, who sent it to me at Chikagoua whence I started in 1700, on the 8th of September to come here."

(Prof. Alvord continuing):

Taken in connection with all of the context this indicates that Father Gravier used the Chicago DesPlaines river route in going to the mission as the Jesuits were accustomed to do.

REPORT OF RAMEZAY AND BEGON, 1715.

The book which is now shown me is volume 16 of the collections of the State Historical Society of Wisconsin. The last few volumes of this collection, among which this is, were

edited by Doctor Reuben G. Thaites, and he has included in them documents relating to the history of Wisconsin and the west in general, and where the documents were in French he has made a very careful translation which is regarded as authoritative and accurate. Volume 16 is a collection of various documents illustrating the French regime in Wisconsin. The document begins on page 327 and is entitled "Military Preparations against Foxes. Traders and Voyagers. Their Lawlessness. Restrictions on Trade. English seek to Control Fur Trade. French should Establish New Posts. (Letter of Ramezay and Begon to French Minister; dated November 7, 1715. Ms. in archives of Ministere des Colonies Paris; press-mark "Canada, Corresp. gen., Vol. 35, c. 11, fol. 15')".

Ramezay was commandant at Montreal at this time and Begon was the intendant of Nouvelle, France. The French administration of a province, whether in France or in America was in the hands of the Governor General and of the intendant of the police, justice and finance. The authority of these two officers was very great and the line between their functions was not sharply drawn. That was the principle of the French government to have two officers of almost equal authority residing within the province so that they could watch each other. The intendant, therefore, was what might be called the chief justice, civil governor, and chief of police of the province of Nouvelle, France. Begon is one of the well known intendants of that colony.

The nature of this document which I now refer to is a general description of the West and the necessity of military preparations against Indians and against the English who are just beginning to come into the western countries for the purpose of trade. It has particular advice to the French minister, to wit, a series of forts should be made in order to protect the country against Indians and against the English. It has in mind the protection of the fur trade. The

passage begins on page 331 and is as follows:

16 Wis. Hist. Col. 331:

"Sieur de la Perriere, who came down from Michilimakinak to Montreal at the end of last month, and who was charged with letters from Monsieur de Lignery has informed Sieur de Ramezay that about 100 Frenchmen who secretly went up to Michilimakinak two years ago, after consuming the wears of the merchants who had equipped them, went to the Thamorois on the Mississippi river, where 47 were already established. He reports

that they are living there at their ease; as grain thrives in that region, they have built a mill and have a great many cattle. They get as many savage slaves as they wish, on the river of the Missouris, whom they use to cultivate their land; and they sell these to the English of Carolina, with whom they trade. This settlement is a dangerous one, serving as a retreat for the lawless men both of this Colony and of Louisiana. But as we see no possibility of preventing it, we believe, Monseigneur that we might render it useful for the service of the kind and of the colony by sending there a dozen soldiers, commanded by an officer, who could build a fort there and gradually establish order among these Frenchmen. With them he would be able to oppose the building of Forts by the English and all the enterprises carried on by them in that territory, which has been considered as French since the founding of the colony. As it is only about 60 leagues from the Thamarois post to that of ouabache, the French in either could, in case of need, come to the help of the other. It would also be very useful to establish a post at Chicagou to facilitate access to the Illinois and the Miamis and to keep those nations in our interest."

MEMOIR ON SAVAGES.

(Prof. Alvord continuing):

The passage now shown me, which appears on page 372, of the same volume 16 of the Wisconsin State Historical Collections, is a manuscript headed "Memoir on the Savages of Canada as far as the Mississippi river, Describing their customs and trade. (Translated from a Ms. in archives of Ministere des Colonies, Paris; press mark, "Canada, Corresp. gen., vol. 39, c11, fol. 354.)" This is in the nature of a report concerning the savages of Canada as far as the Mississippi river and describing their custom and trade. There is a passage there which refers to the DesPlaines river on page 372.

Whereupon said passage was read into the record as follows:

16 Wis. Hist. Col. 371:

"The quicapoux and the mascoutins are not far from Chicagou, it may be fifty leagues distant. When they wish to go to Detroit or the St. Josephe river they have to pass by way of Chicagou.

The River St. Josephe is to the south of Lake Michi-

gan otherwise called Lake of the Illinois. Many follow this river to go to LeRoche, because it is a fine river and they thus avoid the portage des chesnne and that of des perche. It is a river at the end of Lake Michigan and goes to LeRoche, which is an Illinois village."

(Prof. Alvord continuing):
The footnote on that page, 372 is written by Dr. Reuben
G. Thwaites, whom I have referred to heretofore, and is explanatory of the passage which has just been read and is as

follows:

"The St. Joseph river formed with the Kankakee (which was reached by a portage of three to five miles in length, at the present South Bend, Ind.), a convenient route from Detroit to the Illinois settlements. Of the portage here mentioned, that of des Chesnes ("the oak trees") was the one from the Chicago river to the Des Plaines—the earliest and best known route between Lake Michigan and the Mississippi, the other, des Perches (the poles), was probably that from the Calumet river to the Desplaines at the present south Chicago."

REPORT OF JAMES LOGAN, 1718.

(Prof. Alvord continuing):
The book which is now shown me is entitled "Chicago Antiquities, Comprising Original Items And Relations, Letters, Extracts, And Notes, Pertaining to Early Chicago, Embellished With Views, Portraits, Autographs, Etc., by Henry H. Hurlbut." Mr. Hurlbut had collected into his volume extracts of newspapers, letters, etc., which have come to his hands and has published them. The documents so published are regarded by Historians as correctly transcribed and as having the authority of the original, being accurate reproduc-

tions of the originals.

The passage to which my attention is called in this book is

on the top of page 171. As Mr. Hurlbut describes it:

"The following is an extract from a 'rough draft' by James Logan, bearing date, December, 1718, designed to aid Gov. Keith, of Pennsylvania, in preparing his Memorial to the British Board of Trade. Various other routes to the Mississippi were referred to in the same paper." The foot note which tells who James Logan is is as follows:

"James Logan was born in Ireland, of Scottish par-

entage in 1674. He was a precocious scholar, being proficient in many of the dead languages at the age of 13 years. He came over with Wm. Penn on his second visit to America as his secretary, landing at Philadelphia in Dec., 1699. He filled with ability many offices in the Province, including that of Chief Justice as well as officiating as President of the Council, also as Governor for two years. 'He was a firm friend of the Indians; possessed uncommon abilities and great wisdom and moderation.' He died near Philadelphia in 1751."

(Prof. Alvord continuing):

He helped Governor Keith in drawing up several papers. Governor Keith published a volume upon the colonies and Governor Keith and Logan are regarded as men that were very familiar with colonial affairs.

The passage from Mr. Logan's report is as follows:

"From Lake Huron they passed by the Strait of Michilimakina four leagues being two in breadth and of a great depth, to the Lake Illinoise; thence one hundred and fifth leagues on the Lake to Fort Miami, situated at the mouth of the river Chicagou. This fort is not regularly garrisoned. From hence came those Indians of the same name, viz., Miami, who are settled on the forementioned river" (Miami now Maumee) "that runs into Erie. Up the River Chicagou they sail but three leagues to a portage of a quarter of a league. They then enter a very small lake of about a mile and have another very small portage and again of another of two miles, to the river of Illinoise; thence down the same one hundred and thirty leagues to the Mechasipi."

(Prof. Alvord continuing):

The object of the preparation of this rough draft of the report to the British Board of Trade by Governor Keith was that the English traders were now beginning to go in great numbers across the mountains and were beginning to realize more fully than they had previously that the French were occupying an extremely fertile valley and were likely to cut them off at the mountains. Governor Keith, being Governor of Pennsylvania, where many of the traders who were west of the mountains came from was extremely interested in this possibility and desired to draw the attention of the Board of Trade and through the Board of Trade of the British ministry to the danger that was threatening the British possessions in America from French operation.

REPORT OF THE BRITISH BOARD OF TRADE, 1721.

Volume 19 of the Michigan Pioneer and Historical Society, which is now handed me, is regarded by historians as containing documents in an authoritative form. This particular volume contains many copies of papers on file in the archives of the Dominion of Canada at Ottawa, and this particular document on page 5 is a copy of a representation of the Lord's Commissioners for trade and plantations to the King, upon the state of his majesty's colonies and plantations on the continent of North America, dated September the eighth, This is the report of the Board of Trade to which was sent the report of Governor Keith of Pennsylvania. Board of Trade was founded for the promotion of the trade between the British colonies and the mother country and all matters pertaining to the Colonies generally were first referred to the Board of Trade for investigation and report. There was scarcely any action during the eighteenth century taken by the British Ministry or British Parliament concerning the Colonies without a report from the Board of Trade. The Board of Trade collected its information from reports from governors and other officials and even from private individuals. It was founded for the purpose of collecting such information and its archives are among the richest in London for colonial history. The report of the British Board of Trade would be regarded by historians, concerning matters in the United States with which that report had to deal, as a report of a body whose purpose it was to investigate, and as giving the information which the Board at that time possessed.

On page 5 of said volume there appears the following:

(19 Mich. Pioneer & His. Col. p. 5):

"From the Lake Huron they pass by the strait Michilimackinac four leagues, being two in breadth, and of a great depth, to the Lake Illinois; thence 150 leagues on the lake to Fort Miamis, situated on the mouth of the river Chicagoe; from hence came those Indians of the same name, viz.: Miamis, who are settled on the forementioned river that runs into Erie.

Up the river Chicagoe they sail but three leagues to a portage of one-fourth of a league, then enter a small lake of about a mile, and have another very small portage, and again another of two miles to the river Illinois; thence

down the stream 130 leagues to Mississippi."

CHARLEVOIX'S LETTER.

(Prof. Alvord continuing):

The title of the book now shown me is "Journal of a Voyage to North America, Undertaken by Order of the French King. In a Series of letters to the Dutchess of Lesdiguieres. Translated from the French of P. de Charlevoix. London 1761." The book covers the time Charlevoix made a journey for the purpose of examining the French colonies in 1721, and this is a publication containing letters that he wrote back to France from the various points that he visited. Charlevoix is regarded as a man of ability who was chosen by the King for this particular purpose, to make a journey to the French Colonies and to report on what he saw. He has an excellent standing among historians, and historians would use this book as the most excellent source material.

A passage beginning on page 165, as follows:

"Fort on the River St. Joseph, September 14, 1731.

Madam:

It is now three days since I set out from this place for Chicagou, by coasting along the south shore of Lake Michigan; but we found the Lake so stormy that we resolved to return hither and to seek out some other way to reach Louisiana. Our departure is fixed on the 16th, and I am going to make use of this delay of two days to continue my account of the customs and traditions of our Americans."

Also the passage from page 183 as follows:

"Source of the River Theakiki, September 17, 1721.

Madam:

I believe I gave you to understand in my last that I had two routes to chuse, in order to gain the country of the Illinois; the first was by returning to Lake Michigan, coasting along the southern coast and entering the little river at Chicagou. After ascending five or six leagues up this river, there is a passage to that of the Illinois, by means of two carrying places, the longest of which is not above a league and a quarter; but being informed that at this season of the year there is not water sufficient for a canoe, I have taken the other route, which has likewise its inconveniences, and is far from being agreeable, but it is more certain."

(Prof. Alvord continuing):

Having in mind the context, I would state that Charlevoix

took the St. Joseph and Kankakee route and the other route to which he refers is the Chicago and Desplaines portage. There is nothing in any of the writings of Charlevoix to show that he used the Chicago Desplaines River, and in fact he only passed through the country this one time, and he shows by his own writings that he took the route by the St. Joseph. The fact that he went through the country only once is regarded as an established fact, and I would state that there is no reference in his writings to the use of the other portage, from my own investigation. There is another passage on page 184 which shows a little more affirmatively that he did use the portage to which I have referred as being used by him.

Said passage is as follows:

(Charlevoix) 187:

"I departed vesterday from the fort of the river St. Joseph, and sailed up that river about six leagues. I went ashore on the right, and walked a league and a quarter, first along the water side and afterwards across a field in an immense meadow, entirely covered with copses of wood, which produce a very fine effect; it is called the meadow of the Buffaloes head, because it is said a head of that animal of monstruous size was once found there. Why might not there have been giants among the brutes! I pitched my tent on a very beautiful post, called the fort of the foxes, because the foxes, that is to say, the Ontagamies, had not long ago a village there, which was fortified after their fashion.

This morning I walked a league father in the meadow, having my feet almost always in the water; afterwards I met with a kind of pool or marsh which had a communication with several others of different sizes, but the largest not above a hundred paces in circuit. These are the sources of the river Theakiki, which by a corrupted pronunciation our Indians called Kiskiki. This signified a wolf, in I do not remember what language, but this river bears that name, because the Mahingans, who are likewise called the wolves, had formerly taken refuge on its

bank.

"We put our canoe which two men had carried thus far into the second of those springs, and we embarked ourselves, but we had scarce water sufficient to keep her afloat. Ten men would in two days make a straight and navigable canal which would save a great deal of trouble and ten or twelve leagues of way; for the river at its source is so very narrow, and such short turns must of necessity be constantly made, that there is danger of damage every moment to the canoe, as has just now happened to us. But we shall now return to the Indians, and after having seen in what manner they are treated during sickness, we shall take a view of them whilst they are a-dying, and of what passes after their death."

(Prof. Alvord continuing):

I have been reading from a translation made in 1761. The English people were particularly interested in all they could learn of the West at this time, and we have a great many publications from themselves; but also they translated the French Works and this is one of those translations. It is regarded by historians as a correct translation.

JOHN MITCHELL'S STATEMENT.

The book to which my attention is now directed is entitled "The Context in America between Great Britain and France, with its Consequences and Importance. By an Impartial

Fand, London 1757."

The outbreak of the French and Indian War was due to the struggle between France and England for the possession of the Ohio country immediately and developed into a struggle for the possession of the whole west. The contest aroused the interest of the people of Great Britain and the Colonies, and a very large number of pamphlets were issued from the press concerning it. The most important pamphlet of the kind is this one, known as "Contest in America, By an Impartial Hand." It was soon known in England and America that the impartial hand belonged to John Mitchell. Such is the generally accepted historical fact as known by contemporaries and has been known ever since.

In 1773 the famous Arthur Young, economist, wrote a pamphlet on the possibility of western colonization in America, and he used portions of this book, and directly ascribes them to John Mitchell. I have myself made comparison with the passages he quotes in his foot notes with the passages in this book, so that I determined for my own self

that the author of this book was John Mitchell.

Q. Before reading the passages you have before you and in order to make clear the meaning of the passages I wish you would state the historical fact with reference to the part

if any which this fur trade played in the contest between

France and England?

A. As we have already seen, the French were the first to get hold of the fur trade of the Great Lakes and the Mississippi Valley regions, on account of their location on the St. Lawrence River. They were able to practically monopolize it for some time, although the Albany merchants in the Colony of New York were able to draw furs from this region by means of the Iroquois Indians. This, however, did not affect the Pennsylvania and Virginia merchants who were obliged themselves to go into the interior by crossing the Alleghenies. They therefore were the first ones among Englishmen to get

into the western country.

By the middle of the second decade of the 18th century the French complained of the English traders on the Wabash, and for that reason they built the post at Vincennes. During the war known as King George's War, the French realized more fully the danger to their western country from the English colonies. Explorations by them in the upper Ohio showed that the country was full of English traders, and that they were in danger of losing the land not only for colonization but for the fur trade. They therefore determined to make a desperate attempt to close in the English people at the Alleghenies by locating a line of forts all along the rivers at the back of the Alleghenies, and thus cut off the passages that the Colonials were using in their pursuit of game.

Between the years 1750 and 1754 this line of forts was made and it was because of these activities on the part of the French that the English brought on the French and Indian War which was an undeclared war for two years carried on on the upper Ohio, a war in which George Washington partici-

pated.

On page 78, paragraph 3 there appears the following:

"III. Their next view is, to secure those extensive territories, that they thus lay claim to; for which they have left no stone unturned for many years. For this purpose they have been securing one place after another, and building fort after fort, for many years. We see the plan and system they have laid down in North America, and all their proceedings are directed and tend immediately to execute and accomplish it. With this view they proceed from north to south across that continent, and seize every convenient place in their way; in order to

join their two colonies of Canada and Louisiana together. For this they have hitherto been obliged to go a vast way around about, by four of the great lakes and thence down the river Illinois into the Mississippi. But seeing a nigher and more convenient pass by the river Ohio, they at last seized that."

(Prof. Alvord continuing):

The first word of that passage, "their," refers to the French, taken in connection with the context.

Instructions for Drafting the Treaty of Prace to Conglude the French and Indian War, 1761.

The document to which I am now referring is entitled "Affairs, etc., Correspondence, Politique etats Unis Supplement, Vol. 6, fols. 104-112." This document was enclosed in a letter written by the Duc de Choiseul on the 10th of August, 1761, wherein he said: "I send you a memorial on the limits of Louisiana which I have previously told you about, and which has appeared to me very well made."

This work was prepared under the circumstances that by the year 1761 the most important questions concerning North America that had led to the French and Indian War between

Great Britain and France had been settled.

Under William Pitt, the British arms had been triumphant in America, Canada had been occupied and the fort that the French had built at the forks of the Ohio had been taken, so that it seemed possible both to the French and the English

that a treaty of peace might be made.

The situation in England from the point of view of the French Minister was very favorable. In 1760 the young George III had come to the throne and he with his favorite Lord Bute were in favor of making a peace as soon as possible. The Duc de Choiseul was prime minister of France at this time, and sent to London as his agent a man by the name of DeBussy to enter into direct negotiations with William Pitt. Choiseul did not give Bussy discretionary powers; he was simply the agent of the French Minister and this memorial was sent by Choiseul to his agent, showing about what he was ready to concede to England and also along what lines he was ready to make the treaty of peace. The negotiations were opened up in 1761 failed by the fall of that year and the war was continued until the treaty was made in 1763.

This document which I have before me is a copy of the docu-

ment the history of which I have just given, and the original of which is found in the place here designated. The copy was made for me some time ago because I was interested as a historian in that treaty of peace, and was made for an entirely different purpose than introducing it here. The copy was corrected by Mr. Waldo Leland, the agent of Carnegie Institute in Paris, and he took great care to see that I received a correct copy as it was of the utmost importance, for the uses that I was going to make of it. The original from which the copy was made is in Paris. I do not know in whose handwriting the copy is that is before me. Mr. Waldo Leland who has collated it and made corrections furnished it to me as an accurate copy of the document in Paris for use in an entirely different matter than the one in which I am now using it.

The said passage reads as follows: (Memorial on Louisiana by Choiseul):

"In the uncertitude in which France is that the position of affairs may decide her to cede Canada to England, the true manner of determining a general plan of the limits for Louisiana as well on the side of the English colonies as on the side of Canada is, to commence by making out a schedule of the natural advantages of Louisiana and of Canada. The purpose of this business is to have a result which may serve as a guide in the operation.

For the belligerent parties in America have not for their object in the present war the extent of territory, but only the profit that may be drawn from the country

in contention between them.

With this point of view the spirit in which one should work in establishing the limits of Louisiana is to regulate them in such a manner that they do not take away any advantages which render this colony and that of Canada of some value for France, or that they cause the least possible loss.

This is the principal point and, indeed, the only one. Since this point will not suffer extinction whatever the extent of territory may be by the cession, it becomes indifferent, perhaps even it is useful. Advantages limited in a less space may appear preferable to the same ad-

vantages scattered in a very great space.

Before then presenting any idea on the limits of Louisiana, it is best to show in what the natural advantages of this colony and of Canada consist and in what

they interest France. These two colonies embrace vast countries filled with fertile land and whose climate is healthy although the temperature is very different in the the parts situated under the most distant parallels. Canada furnishes grains, vegetables, hemp, cattle, copper, peltries, among which is the articles of beaver, timber, tar, gensing, iron, fish oil; it has mines of lead.

Peltries, particularly beavers, copper, timber are the most interesting parts of the production of Canada in which old France can not supply herself from her own

From this short exposition there result two points: one that the conservation of Canada interests France only in relation to certain productions. If in ceding Canada one manages limits which preserve for France these same productions, the cession of this colony is not a loss. It is necessary to observe that the peltries and beaver especially are exhausted in environs of Quebec and for one hundred leagues around this village one no longer gathers them for a long period. Peltries and beavers in which the Canadians trade (this amounting to 18,000 livres per year) come to them from a great distance in the west and north. These merchandise come into their hands in two ways: from the Outouacs and other savages neighboring the western banks of Lake Superior who come by way of the Lakes to Montreal or by coureurs de Bois, that is to say by the colonists who trade in peltries in the woods. These journey to the lakes and traffic in the country of the savages of which one has just spoken, or indeed they betake themselves to the southern extremity of Lake Michigan whence by means of a very short portage, which one calls the portage aux Chenes, they descend by the river, the Illinois, into the Mississippi. They then journey up this river and sometimes also the Missouri, and trade with the Penis, Sioux and other numerous nations who inhabit the north of Louisiana. These coureurs de Bois thus are accustomed to seek the skins which they bring back at eight hundred leagues from Quebec. It is easy to see in examining the map that they would have a shorter journey and less difficult by going to New Orleans than to Quebec, and that the savages who are accustomed to bring their booty to Montreal would have less journey and a less hazardous road than that, and one in which they would be less exposed to ambuscade by the

savages their enemies, in carrying their packages to the souther banks of Lake Michigan, near which is the post of the Illinois, one of the best established of Louisiana.

* To this observation concerning peltries it is necessary to add the subject of copper, hemp, timber, which one draws from Canada, first that a great part of this copper comes from the same countries where the coureurs de Bois are accustomed to seek the peltries; second, that the forests with which are covered the countries watered by the Missouri by the Mississippi, and by the rivers without number which empty into the two rivers, will furnish if one wishes to take the necessary care therefore, as much hemp and timber as one could have need of.

So that in order to lose nothing of the productions of Canada in ceding this province, the only attention that there is need to have in the establishment of the limits of Louisiana on this side appears to be to preserve the exclusive navigation from Lake Michigan from Lake Huron and from Lake Superior, in order that the savages of the north and of the northwest may have an easy and sure

access to the Illinois post."
(Prof. Alvord continuing):

Mr. Leland states that this document is to be found in two

places. He has given me the following note:

"This memorial is found (as copied) in Affair etr. Correspondence Politique Etats Unis Supplement, Vol. 6, fols. 104-112; and also in affairs etr. Correspondence Politique Angleterre. In Vol. 6 (Etats Unis) there is nothing to identify it, but in Vol. 444 (Angleterre) is found the legend

'Envoye copie a M. de Bussy le 10 Aoust 1761."

This document was written for the purpose of showing that the boundary line between Canada, which was to be ceded to Great Britain, and the French province of Louisiana which it was expected that France would retain, could be so drawn that the benefits that France had up to this time received from Canada might still be retained. The memorial points out that the chief products of Canada, particularly of peltry, copper and so forth, were obtained in the region of the Great Lakes and if the boundaries of Louisiana were so drawn as to control the waterways from Lake Michigan into the Mississippi, then the trade of this region could be conducted by the French traders and brought by means of water routes down the

Mississippi to New Orleans, even if Great Britain was put

in possession of Canada.

This memorial was prepared for the negotiations looking toward peace that was entered into between the British government and the French government in the year 1761. The result of these negotiations was that the two countries failed to reach any agreement in regard to the boundaries of Canada. Also the Duc de Choiseul had entered into negotiations with Spain for the purpose of getting the support of Spain for

France in making peace.

William Pitt, the British minister, had followed the Spanish French negotiations with considerable care and decided that if Great Britain was to reap all the advantages of the war, she must declare war upon Spain also. He proposed that to the Ministry and since they would not follow him, he resigned. The treaty negotiations were broken off, however, and England and Spain actually did enter into a war, the results of which changed the conditions very materially and resulted in the treaty of Paris in 1763. The result of the treaty at Paris in regard to this particular territory was that the French ceded to England Canada and gave up all of her claims in Louisiana east of the Mississippi River with the exception of New Orleans and the land contiguous. The particular territory in which is now situated the State of Illinois passed by this treaty into the hands of Great Britain.

Illinois, as a district of the Province of Louisiana, included all of the region between the Ohio and the rivers flowing into Lake Michigan. On the east this was bounded by the Wabash in general, and on the west its extent was from the Arkansas River indefinitely northward, that is, west of the Mississippi. In this region the French had certain posts that had been established. The seat of government was at a place that is known by the English term of Fort Chartres, the French name being Fort de Chartres. Situated on what is known as the American Bottom. Beside Fort de Chartres we have the following French villages also on the American Bottom, that is, extending from East St. Louis to Chester. Beginning at the North, Cahokia, St. Phillipe, Fort de Chartres, the village of which was known as New Chartres, Prairie du Rocher and Kaskaskia. Here they had a population of probably at this time under two thousand. None of these posts were on the Illinois River. They were all on the Mississippi River.

STATEMENT OF THOMAS HUTCHINS, FIRST SURVEYOR GENERAL OF THE UNITED STATES (1778).

This book which is now shown me is entitled Topographical Description of Virginia, Pennsylvania, Maryland and North Carolina, by Thomas Hutchins. It was published in London in 1778, and is the original edition. Thomas Hutchins calls himself in this book Captain in the 60th Regiment of Foot. Hutchins was a captain in the British army and fought during the French and Indian War against the French. He was one of the civil engineers employed by the British government in making maps of the west. We find him employed in Florida, on the Great Lakes, at Fort Pitt, making maps of the upper Ohio region. In 1766 he is in the Illinois country with the

post at Fort Chartres mapping that region.

His map of the Illinois region was the basis for future maps of the region for many years afterwards. He visited Lake Michigan and Green Bay, and probably there was no man in the British army previous to the breaking out of the Revolutionary War who had a better knowledge of the west than Thomas Hutchins, and his information was used by the British ministry. He sympathized with the Americans at the outbreak of the Revolutionary War, and after the close of that war his reputation as a surveyor resulted in the appointment by the United States Government of himself as first surveyor general, and in that position he was the first to lay out the land on the upper Ohio around Marietta. This particular volume has been used again and again by historians as authority for statements concerning the west. I find in it a passage which refers to the Chicago-Desplaines at page 42, as follows:

"The Illinois river furnishes a communication with Lake Michigan by the Chicago river, and by two portages between the latter and the Illinois river, the longest of

which does not exceed four miles."

LETTER OF CAPTAIN BREHM TO GENERAL HALDIMAND, MAY 8, 1779.

(Prof. Alvord continuing):

Volume 19 of the Michigan Pioneer Historical Collections contains a large number of transcripts that were contained in the Canadian Archives at Ottawa, taken from what is known as the Haldimand Papers. General Haldimand was a Swiss officer who entered the British army and served for many years therein. He was in the French and Indian War. After

the war was closed he was sent to Florida as Governor, and then transferred from Florida to Canada, where he was Governor General for some time after the outbreak of the Revolutionary War. He had a vast correspondence of course, with army officers, and other people throughout the colonies. This correspondence he kept very carefully. It was finally given to the British Museum where it is situated today. Some years ago Douglas Brynmer was Archivist of the Dominion Archives, and he obtained copies from the British Museum for the Dominion Archives which copies have been used again and again by state officials and historians. The Michigan Pioneer and Historical Collections have reproduced here in print some of these documents. I find among these documents letters that refer to the "Chicago Desplaines." These copies are regarded by historians as authentic transcripts of the originals. The first of these letters is from Captain Dederick Brehm to General Frederick Haldimand, Niagara, 8th May, 1779. The passage in question is found on page 405 and is as follows (19 Mich. P. & H. Col., p. 405):

"After considering the situation of Major de Paister I apprehend he runs more risk from Chicagu by the Illinois River, then Capt. Larnould, as your Excellency will have and yet see, what precautions and means Col. Bolton has taken and is still constant sending partys towards Tuscarowas, and Fort Pitt to harass and disturb their proceedings but Clark having reduced Vincennes as early as February may have time to attach de paister by the above mentioned river, if the least preparation has been

ordered by him at his leaving the Illinois."

(Prof. Alvord continuing):

This is a letter concerning a possible attack on the part of Virginians in Illinois territory against the British posts. This is an official letter from Captain Brehm to his Superior, General Haldimand.

LETTER OF CAPT. BREHM TO GEN. HALDIMAND, MAY 12, 1779.

In the letter in the same volume, page 410, he refers to the same Chicago-Desplaines portage. It is a letter from Captain Dederick Brehm to General Frederick Haldimand, dated Niagara, May 12, 1779. It is an official letter from Captain Brehm to his superior officer and reads as follows:

"Col. Bolton has ordered some spades, shovels and Pickaxes to be got from this place, the former from Merchants, he having none in store which I intend to carry up to Detroit for the use of said place or Michilimackinac, for which last Post I apprehend the most by the way of the Illinois & Chikago Rivers over Lake Michigan."

LETTER OF _____ TO CAPTAIN LANGLADE, 1780.

(Prof. Alvord continuing):

Mr. E. E. Ayer has made a collection of manuscripts on western history, and also of books on western history that is extremely well known throughout the country and contains a great many manuscripts of great value. This particular manuscript is regarded by historians as an original manuscript. This copy is in print. I have translated the certified copy and my translation is accurate to the best of my knowledge and belief.

It is as follows:

"To M. Capt. Langlade, Commandant of the Troops of His British Madjesty, ordered to make war upon all rebels all subjects of Spain or any other alien or domestic

power allied with the said rebels.

Sir: You are commanded to put your detachment on land as near Milwaukee as the circumstances will permit and without losing time to get across the land in order to gain the first village of Illinois which is named Peoria. You will send by canoes as much provisions as you will find necessary by the River Chicago, taking good care not to overload your canoes and that they are sufficient in number to carry your detachment to Cahokia, the village opposite St. Louis. * *

Hasten to set out quickly in order to inform M. Louison Hamelin to follow you by the same route and keep him informed of your march from time to time. In case you do not have on your return boats at Milwaukee or Green Bay, buy canoes in order to reach here.

There is nothing in the manuscript to show by whom it was written. It might have been written by several military officers of Great Britain. Evidently it was an official letter to Captain Langlade. There is nothing in the letter to show the date, but the circumstances are such as to place it in the year 1780.

LETTER OF PATRICK SINCLAIR TO LIEUTENANT COLONEL BOLTON.

Turning to Volume 19 of the Michigan Pioneer and Historical Society Collections, already identified I find in it a

letter written by Patrick Sinclair, on page 529.

Patrick Sinclair was Lieutenant Governor following De Peyster at Michilimackinac when the latter was transferred to Detroit. This letter was written at Michilimackinac and seems to be an official letter written to Lieutenant Colonel Bolton, a lieutenant colonel in the British army. The letter is dated at Michilimackinac June 4, 1780, and is as follows (19 Mich. P. & H. Col., 529):

"I have the Honor to enclose you Returns of the Garrison, which account for all casualties since Major de Pay-ster's Departure.

ster's Departure.

The Sloop Felicity with a small Vessel, private property, went into Lake Michigan and on the 29th Ultimo to land a Party of Canadians and Indians, who go by the Illinois River to second the attack of a Thousand Traders, Servants and Indians, sent down the Mississippi in obedience to my Lord George Germain's Circular Letter. * * *

The Two Vessels are returned from Lake Michigan with a part of the Indians & Volunteers on the attack against the Illinois, scarcity of Provisions obliged them to return by different Routes some by the Mississippi, some through the Country between Lake Michigan and that River, and some as directed by Chicagoe."

PLAN OF AN EXPEDITION BY LA MOTHE.

(Prof. Alvord continuing):

This volume which is now shown me is volume 10 of the Michigan Pioneer Collections which is one of the volumes already referred to. Volume 10 contains some transcripts of the Haldimand papers. On page 569 is a plan of an expedition against the Illinois drawn up by Giulhaume LaMothe, a Frenchman of Detroit, who joined the British and was captain of their militia in Detroit. It is dated April 24, 1782. It is a document drawn up to be presented to the military authorities and is as follows:

"April 24th, 1782.

Plan of an Expedition against the Illinois, which I have the honor to present to your Excellency. Leaving Detroit with a small army of & some neighboring indians,

Sauteaux, Hurons & Misthey will come by land to St. Josephs a journey of eight or ten days. Then after having taken the poux Nation, who are settled on this river they will come to the branch of the Chicagouet & the Quinquiqui to try to get the Indians of the small fort of Milanaquis & another village, who have appeared, till the present to give their services to the Illinois & Lately conducted a party to St. Joseph who took the Commandant placed there by Governor St. Clair. As the two villages are the refuse of all the malefactors of all the other nations of which the two chiefs are Dougurne Sauteux, the one named Segurnac & the other Macquivois who had their families near Michilimackinac & it would be easy for the leader of the party to send them with the belts & we would by these means keep back the intelligence which they would have given to the enemies. During this time we could bring the barges & ammunition & go to join the little army at the entrance of the Chicagous where is a portage of half a league in good weather, in this way we could come without difficulty to the Illinois."

(Prof. Alvord continuing):
Referring now to the last five letters or documents, these documents have to do with the use of the Chicago Desplaines portage by the military forces of Great Britain in making an attack upon the Illinois country in possession of the Americans, and upon St. Louis, which was in the possession of Spain.

Q. State what object a historian would consider these various officers had in referring to the Chicago Desplaines

route as a means of transporting troops.

A. The Chicago Desplaines route seemed to them to be a very convenient route to get down the Illinois country.

TRIP OF JOHN BAPTISTE PERRAULT.

The book now shown me is entitled "Archives of Aboriginal Knowledge. Containing all the Original Papers laid before Congress respecting the History, Antiquities, Language, Ethnology, Pictography, Rites, Superstitutions, and Mythology of the Indian Tribes of the United States. By Henry R. Schoolcraft, LL. D. In six volumes. Philadelphia 1860." This is volume 3.

Henry R. Schoolcraft was what we designate, probably by reason of his most important publications, an ethnologist, a student of the Indian tribes, although his interests were very broad. He was one of the earliest and has remained one of the best known of the men dealing with this particular phase of our history. He traveled excessively throughout the west, visited a very large number of Indian tribes, explored many rivers, and his works are regarded as of high standard and accuracy. If we find in his book here a reference to the use of a certain route by certain traders, historians would consider that incident as being reported by a man of careful observation and one who had trained himself in the habit of recording. The incident would be regarded by historians in general as an authentic report of the incident which it purports to record. I have found a passage which refers to the Chicago-Desplaines portage. It is a document regarding the testimony concerning Indian life in the northwest in 1763 by John Baptiste Perrault. On page 353, occurs the following (3 Schoolcraft's Indian Tribes," etc., p. 353):

"My deceased father was born at Quebec in 1732, being of a respectable family of that city. He finished his studies at the age of twenty, under the French government, who gave him a situation at the foundery of St. Maruce. After the taking of the country by the English he was stationed at Trois Rivieres, in the capacity of an Inspector, under General Haldimand. In 1770, he commenced merchandizing at Rivere duLoup, from whence I was sent at a suitable age, in 1776, to the College of Que-

bec, where I remained until 1782.

My father, having dealings with Mr. W. Kay of Montreal, sent me about the middle of March, 1783, to adjust them. Then I was first seized with the desire to travel, seeing the preparations making by M. Marchisseaux merchant voyager, a friend of my late father, who had recommended me to his house. I declared to my father my intentions on the subject, and with his consent, I returned to Montreal on the first of April, and agreed with that gentlemen to go to the Illinois in the capacity of a clerk, at the price of a thousand livres and twenty sole, being exempt from all servile labor; to set out on the first intimation."

(Prof. Alvord continuing):

I find in the same article a reference to the use of the

Chicago-Desplaines portage as follows:

"On the 16th of May, 1783, I received the orders I had long desired; for I had figured to myself the great advantages I should derive from that calling. M. Marchis-

seaux directed me to assemble the men whom he had engaged at Montreal for the voyage; namely, Sacharite, Quebec, St. Germain, Robert Dupuis of Maskinonge, Antoine and Francis Beauchemin, Menard L. Lavelle of Sorel and Yamaska; to conduct them to St. Francis, and take from the Wabanakis two canoes, and bring them to

the house of M. Marchisseaux.

On the 12th day of May, at one o'clock in the morning. took leave of my mother, who pressed me to take supper, but my heart was too full to permit me. I had, at the time, a presentiment of what in reality took place before I again returned. I withdrew amidst a burst of tears. accompanied by theirs. I proceeded to St. Francis to take the canoes; and arrived at Montreal on the 15th On the 16th, I received orders to go of May, at noon. and conduct the equipages to LaChien, where the waters from the north detained us till the 27th. On the next day we set out, and encamped at the lake of Two Mountains on the 28th. Our canoes were loaded too heavy. bourgeois (a term in general use among voyageures for the master or proprietor of the adventure) was obliged to We continued our route in get a third to lighten us. safety, and with little detention. The water was, however, so high as to compel our bourgeois to engage two more hands; one of them deserted during the following night.

We arrived at Mackinac on the 28th of June and remained there until the 15th of July. tinued our route towards LaBaye (Green Bay) with the intention of passing by the way of Prairie des Chiens, where we sojourned two days. On the third, being now en derive, we encamped at the Sauk village at Turkey river, about sunset; M. Marchisseaux being necessitated to pass there, instead of the direct route from Mackinac to St. Louis by way of the Illinois, in order to collect his credits from the Indians. We continued our route, and passed St. Louis during the night, fearing a seizure from the Spaniards, who did not at that time, suffer any person to import merchandise into Louisiana from Great Britain. We arrived at Kaos, then under the British government, on the 11th of August. M. Marchisseaux hired two apartments in the house of M. Soucier in the village, to establish a store of Franch goods and sold off his Indian goods to M. Choteau merchant of St. Louis, who equipped

on the Missouri, at an advance of 137½% payable in peltries namely, beaver at one dollar per pound, otter at one dollar and fifty cents; racoons at twenty cents; bears at two dollars; deer skins at fifty cents each; and in the same proportion for other furs."

"That year there were a number of gentlemen from Montreal who had stores at Cahokia; namely Messrs. James Grant, Myers, Tabeau, and Guillon, who had but little business, on account of their having arrived too late.

About the 15th of April the packs from the Missouri arrived. Our bourgeois settled his accounts with M. Choteau, and received seventy-four packs of furs. His retail store at Cahokia produced 500 Spanish dollars, and 400 pounds of tobacco. We left Cahokia on the 4th of May, for Mackinac. My directions were to pass by Chicago, having one barge and one canoe, and to await the arrival of M. Marchisseaux at Little Detroit in Lake Michigan, he having gone by way of Prairie des Chiens, to terminate his business with the Sauks. After fourteen days' detention, he arrived and continuing our route, we reached Mackinac the beginning of July, where I found myself at liberty."

(Prof. Alvord continuing):

Mr. Perrault was an Indian trader, that is, a trader for furs, and was well known for many years throughout the west. He was a prominent man later in Canadian history, and his family is living there to-day. He was of French nationality trading under the British government within the territory which became by the treaty of peace in 1783 United States territory. As to the other references or accounts of similar trading by British traders from Canada, I would say that in Volume 2 of the Illinois Historical Collections, Virginia Series, Volume 1, Cahokia Records, edited by myself, there are contained the records of the court established in Cahokia by the State of Virginia after that territory was occupied by the Virginia troops, under George Rogers Clark. The records show that during the closing years of the Revolutionary War, and years following, there were many English merchants trading at Cahokia. In fact, there was what was known as the English Store there. These English merchants being able to buy their goods cheaper than the Americans were usurping the trade much to the disgust of the local dealers,

and complaints were made to the Court against them, ineffectively. This trade by the British merchants continued until after the War of 1812, the British merchants of Canada practically monopolizing the trade of the Great Lakes region and the Illinois country.

TRIP OF HUGH HEWARD, 1790.

'The manuscript now shown me is entitled "A Journal of a Voyage made by Hugh Heward, to the Illinois Country." This is a transcript belonging to the Chicago Historical Society, and the correctness of which has been authenticated as follows:

"State of Illinois County of Cook.

I Caroline M. McIlvaine, being first duly sworn on oath state that I am the librarian of the Chicago Historical Society, and that in the course of my duty as such librarian, I have personally compared the above and foregoing twenty-seven pages of Hugh Heward's manuscript with the original of said manuscript which was loaned to me by Clarence M. Burton of Detroit, Michigan, and I do further certify that the above and foregoing is a true and correct copy of said original manuscript.

CAROLINE M. McIlvaine.
Subscribed and sworn to before me this 7th day of

November, A. D. 1910.

Edward J. Crocker, Notary Public."

The original manuscript is in the possession of Clarence M. Burton of Detroit, Michigan, who possesses besides this a great many of Hugh Heward's manuscripts and manuscripts of a gentleman named John Askin closely associated with Hugh Heward in the trade of the Illinois country. The original manuscript is in a handwriting which upon comparing with the handwriting of Hugh Heward, appeared to me to be that of Hugh Heward himself. I have examined the original myself. It is regarded among historians that this manuscript in the possession of Mr. Burton of Detroit is the original manuscript of Hugh Heward.

Hugh Heward was a subject of Great Britain and engaged in the fur trade with other British merchants of Detroit, extending operations in various directions over the Great Lakes

and down the Illinois country.

This manuscript is a diary describing a journey from Detroit to Cahokia which he took from Detroit through the Great Lakes and down to the southern end of Lake Michigan and describes his route the rest of the way, down the Chicago and down the Desplaines and down the Illinois River, finally reaching Cahokia. It is dated during the spring of 1790.

Hugh Heward was one of the British merchants who con-

tinued this trade after the treaty of peace was signed.

Said manuscript in part reads as follows:

(Heward MS)

"Sunday, May 9, 1790. Wind at southwest inclining from land. Loaded and set off. Our course in a bend nearly norwest. Strong wind from south southwest, but we recover a little, it being off the land. Arrived at Grand Calmanuck and afterwards at Little Calmanuck, the course norwest. From there arrived by a north course under sail at Chicago, under reefed sail, the wind blowing strong and in blasts. Missed the entrance of the river and were obliged to go about a mile past to land.

Monday, May 10, 1790, Slept at Point Sables. Entered with the Cannots, and began to hull corn and bake bread and arrange everything for next morning. Left the Cannots at Point Sables and took his fur robe. Bought of him forty-one lb. flour, baked in bread for 25 and 29 lb. pork at 2/8 the whole amounting to L %-10-8, and paid him

with 13 yards 4/4 cotton.

Tuesday, May, 11, 1790, Engaged five Indians to help us over the carrying place with pirogue and paid them with two handfuls of powder. Duarrier this morning very saucy and abuseful about getting salt. I promised to requite him for it. A showery day and wind at west. Carrying place about one half mile. Got over nearly at midday. From thence passed in the run and small lake to the river DePlain, and course turning nearly southwest. A very wet afternoon and heavy thunder. Arrived at the river DePlain said to be 15 miles, and encamped.

Wednesday, May 12, 1790. Set off from the river De-Plain which runs from the north. Our course down the Illinois River southwest past Lacroix and after Les Arbre—and a pass that goes in a small lake to the southeast and by this pass it is said to be three leagues to Little Calmanuck on the lake. This about eleven o'clock. Passed the Petit and Grand Toxsil and afterwards the long rapids and came to the Village of Mount Juilette, course southwest. High hill at west resembling Fort Larnoult at Detroit. Pussed afterwards the lake following. Here Maurice informed me not to be surprised, that there was so much danger that he would not return with me. Lomre said he was to make the voyage with him, and if he did not return, he would not.

Thursday, May 13, 1790. Finding the goods not dry enough, and very warm weather coming on, remained to dry them better in the afternoon. Threatened rain. We

were obliged to take them in.

Friday, May 14, 1790. Remained and finished drying the goods and packed up. Belhumor, a Frenchman settled among the Indians, stopped to pass the village at the forks with us. Cool night and heavy thunderstorm.

Saturday, May 15, 1790. Loaded and set off Passed the village at the forks. The chief and village in feast and good humor. Gave him little tobacco and powder and he said he should be ready to assist me. Bought five sacs of corn for four shirts and powder, and paid Belhumor with powder. He was contented but begged two white shirts on credit till my return, which I gave him. He lent me his dog and a teakettle, and gave me nine eggs and a leg of venison. Passed the entrance of the river Teskekie about midday and from here arrived at the rapid of Demi Charge or rapid of (word undistinguishable) ten leagues from Theakekie carried over part and passed the pirogue. Came at the bottom. Elegant land with plum trees, oak, hickory, and so forth. Small sides, high banks."

CORROBORATION BY JUDGE McCULLOCH.

The document which is now shown me is entitled "Early Days of Peoria and Chicago, an address read before the Chicago Historical Society at a quarterly meeting held January 19, 1904, by David McCulloch," which bears the seal of the

society.

David McCulloch was a resident of Peoria, very much interested in the Peoria Historical Society and the local history of Peoria, and the relation of Peoria to Chicago, and this address which was delivered by request to the Chicago Historical Society was delivered at the quarterly meeting on

January 19, 1904. David McCulloch settled in Peoria April 22, 1853. He was elected circuit judge of the eighth circuit and held office until 1885. He was president of the Peoria Historical Society. He was regarded as being the best equipped of the local Peoria Historians, and the Chicago Historical Society regarded his work in local history of sufficient importance to ask him to give them a lecture. Mr. McCullough is dead.

Said passage from his report is as follows:

(Early days, etc., McCulloch, p. 92:) "In May, 1790, Hugh Heward (a copy of whose journal is in the possession of this society) made a trip to the Illinois country, reaching the Chicago River on the 10th of that month, where he found Point de Saible living on the sands. In his journal of the day following he says: 'Slept at Point Sables with the canoes and began to hull corn and bake bread; arranged everything for the next morning. Left the canots (canoes) at Point Sables and took his porogue; bought of him 41 lb. flour and baked bread 25 & 29 lbs pork at 2-8, the whole amounting to 5 pounds 10s and paid him with 13 yds, 4-4 cotton.' According to this account Point de Saible must have been a trader, selling farm produce to the voyageurs and purchasing dry goods from them in return. The prices seem to have been better in those days than on the Board of Trade of today even in times of a corner in wheat or pork.

Heyward proceeded on his journey by way of the portage and the Illinois River to Peoria, where he found a few Frenchmen living among the Indians one of whom was Captain May, doubtless Jean Baptiste Maillet, whose name in French is said to have a sound much resembling May or Mai. He had derived his title of Captain from his having had command of a company of French militia raised at Peoria during or after the war, for which services he was afterwards awarded a donation of one hundred acres of land."

(Prof. Alvord continuing):

The fact that Mr. McCulloch makes use of the Heward manuscript as authentic, in view of the position which he held as judge and president of the Peoria Historical Society would have weight owing to the fact that Judge McCulloch was interested directly in that sort of history and had investigated

the material bearing upon or illustrating that phase of the

history.

I have made an examination of the Heward account from the standpoint of a historian for the purpose of weighing it. In general historians would regard a diary of this sort which purports to be kept by a man going from one place to another, and wherein there is no discoverable motive for deception, as the best evidence of the fact that the men actually journeyed along the line that he had so designated. There is in this manuscript no evidence that he wished to deceive anybody as to the way he went or the method of his journey. On the face of it it is the diary of a trader and his motive is that of a trader, and he does trade as he goes along the journey and he is carrying merchandise to a point where he expects to dispose of it. I see no possible purpose for deception.

REPORT OF GOVERNOR St. CLAIR TO PRESIDENT WASHINGTON, June 11, 1790.

This book which is now shown me is entitled "The Life and Public Services of Arthur St. Clair. Soldier of the Revolutionary War; President of the Continental Congress; and Governor of the Northwestern Territory, with his correspondence and other papers, arranged and annotated by William Henry Smith, Volume 2, Cincinnati, 1882." This is a book of known character and accuracy and is so regarded by historians who have used it to study the correspondence and

papers of Arthur St. Clair.

Arthur St. Clair came to this country and served in the British Army during the French and Indian War. close of that war he took up land in western Pennsylvania, where he became very familiar with the western situation, because just before the outbreak of the Revolutionary War, Virginia and Pennsylvania were struggling for the possession of the forks of the Ohio, both colonies claiming them. They also were extremely interested in the question of the further settlement of the western territory. Arthur St. Clair was the official of Pennsylvania that represented that colony in this dispute with the Virginia colony. At the outbreak of the Revolutionary War he entered the army and became a general in the Revolutionary Army. He was a close associate of General Washington. He afterwards became President of the Continental Congress and was the President of that body when it passed the Ordinance of 1787. He was then appointed

Governor of the Territory northwest of the river Ohio, which territory was formed by the United States, and it was under his administration that the first settlements in the northwest territory made by the Americans were laid out. He was instructed by Congress, and by the President, George Washington, to investigate the whole situation in the northwest, and particularly to investigate the situation with regard to the fur trade and the use of American territory by British merchants.

The report just referred to commences on page 164 and is entitled "Governor St. Clair to the President. Report of Official Proceedings in the Illinois Country from March 5th to June 11th, 1790." In that report I find a portion which bears upon water routes between Lake Michigan and the Mississippi River as follows:

(2 The Life, etc., of St. Clair, 174.)

"The commerce of the Illinois country is of some importance in itself, but more so when considered as connected with the Spanish side of the Mississippi. The villages on that side of the river having been originally settled by the French, and under the same government as that part which is now in the possession of the United States, the connection between them is still very intimate, and favors a commercial intercourse which, though illicit, might be carried on by the citizens of America without risk. It is carried on at present without risk, but is, unfortunately, almost entirely in the hands of the British. Even much the greatest part of the merchandise of the trade of the Missouri River is brought from Michilimackinac by that of the Illinois, partly by the Spanish subjects themselves, and partly by British traders. The manner is this: The Spanish subjects either introduce them at once in consequence of a secret connection with their commandants or they are brought down to Cahokia and landed there, and afterwards carried over to St. Louis, as opportunities can be found. What is brought by the British traders, the Spanish subjects purchase and pay for on the American side taking all the risk that attends the introducing them into their own country upon The furs in which these goods are generthemselves. ally paid for (deer skins answering better than furs at the New Orleans market), are carried to Canada by the same communication, that is to say, up the Illinois river. up the Chicago, and from thence by a small portage into

Lake Michigan and along that lake to Michilimackinac; or from the Chicago up the river Au Plain, and by a

portage into the same lake.

In the spring of the year the waters of the Michigan and the Chicago rise each to such a height that the intermediate space is entirely overflowed, and is passable by the vessels in use there, which are bark canoes, but which carry a very considerable burden and are navigated by three or by five persons."

HISTORY OF GENERAL COLLOT, 1826.

(Prof. Alvord continuing):

This book which is now shown me is entitled "Voyage Dans L' Amerique Septentrional by the late General Collot, Ex-

Governor of Guadeloupe Tome Premier Paris, 1826."

Collot was a French general and writer who was very well known at the close of the 18th century. He was Governor of Guadeloupe and at the close of his service there came to America and made a journey through western America, as so many other Frenchmen did, in the interest of France, which country at that time was looking for some advantage to itself in the west. Collot has the reputation of being a very careful observer and the maps which have accompanied this publication were among the best of the time. The volume was issued in England and France, the English translation being as authoritative as the French original edition; in fact the atlas that accompanied these works was only printed with the English edition. The volume I have here is the French edition, but the translation which will be introduced into the record is from the English edition.

I have taken occasion to compare the translation with the original and the translation is correct. The first passage is from page 325 in the French edition and on page 249 of the

English edition, as follows:

Page 249:

"There are, moreover, strong conjectures that the Lakes Michigan and Superior emptide their waters formerly into this river (Mississippi). The evidence for this conjecture is, that when the waters are high boats carrying from fifteen to twenty thousand weight pass from the Illinois river to the lake Michigan, without portage, by traversing a marsh which joins the sources of the river Illinois with those of the river Chicago which now discharges itself into the Lake Michigan."

Page 257:

"the second by ascending the Illinois river and gaining by Chickago the sources of the river Kennomick (Calumet) which empties itself likewise into the same lake; this may be effected in high waters without carriage, by traversing a marsh where there is four or five feet of water."

BOOK OF GILBERT IMLAY, 1797.

(Prof. Alvord continuing):

The book now shown me is entitled "A Topographical Description of the Western Territory of North America, By Gilbert Imlay, A Captain in the American Army during the War, and Commissioner for laying out lands in the Back Set-

tlements. London, 1797."

I am familiar with this writing as a work of history. is regarded by historians as one of the best contemporary accounts of the west and has been used again and again by historians in their work. Imlay was in the west prior to the preparation of this book. He emigrated to Kentucky and was deputy surveyor of Louisville. He wrote those letters which are contained in this book while he was in Kentucky. I find a reference to the Chicago-Desplaines portage and to the river route between Lake Michigan and the Mississippi river, on page 71, as follows:

(Imlay, Topo, Desc. p. 71):
"I have mentioned that it is about 230 from the mouth of the Ohio up the Mississippi to the mouth of the Missouri and about 20 from thence to Illinois, which is navigable for batteaux to its source. From thence, there is a portage only of two miles to Chicago, which is also navigable for batteaux to its entrance into Lake Michigan, which is a distance of 16 miles. This Lake affords communication with the river St. Lawrence, through Lake Erie passing Niagara by a portage of 8 miles. The lakes Erie and Michigan are navigable for vessels drawing 6 and 7 feet water. This is one of the routes by which the exchange of commodities between the northern and southern parts of this empire will be facilitated."

LETTER OF ROBERT DICKSON TO ROBERT HAMILTON, 1793.

(Prof. Alvord continuing):

Concerning Volume 12 of the Wisconsin Historical Collections, which is now shown me, I have already testified with reference to the manner in which it has been prepared and the reliance to be placed upon it in making historical investigation. On page 133 is an article entitled "Robert Dickson, the

Indian Trader. By Ernest Alexander Cruikshank."

Robert Dickson was a Scotchman who emigrated to Canada after the American Revolution. He became a trader in the Northwest Fur Company and was used as the agent in communication between the Spanish Governor of Louisiana and the Governor of Canada. He was well known as a fur trader and discoverer. During the War of 1812 he led a band of Canadians and Indians against Mackinaw, which he captured. He was, in 1813, made agent for the Indians west of the Mississippi River. In fact, during that war, he and his band reached the Mississippi River in southern Wisconsin. trading in the northwest until about 1823. On page 134 there is "A Letter from Robert Dickson to the Hon. Robert Hamilton of Queenston, describing the usual routes of trade between Mackinac and the Mississippi dated Mackinac, July 14, 1793, probably written at Simcoe's request." I find there a reference to the different water routes between Mackinac and the Mississippi, as follows (12 Wis. His. Coll., 134):

"The communication between Mackinac and the Mississippi" he stated, "is carried on by two routes, the one by Chicago, the other by the Fox and Ouisconsin rivers, the latter is preferred on account of the shortness of the carrying-place. Leaving this place, the navigation is difficult for the course lies on the north side, owing to shoals until the Traverse at the entrance of the bay is reached. The land is poor and barren on the north side of the Lake until near LaBays where the soil is excellent and the seasons are early. Here it has long been settled from Canada by people who sow a little grain and have

about 100 cattle which run in the woods.

TREATY OF GREENVILLE, 1795.

(Prof. Alvord continuing): Thereupon counsel for the Government introduced into the record extracts from a "Treaty of peace between the United States of America and the Tribes of Indians, called the Wyandots, Delawares, Shawanoes, etc.," the same being found in Volume 39 of the Senate Documents at page 39, which extracts were as follows:

"A treaty of peace between the United States of America and the Tribes of Indians, called the Wyandots, Delawares, Shawanoes, Ottawas, Chipewas, Putawatimes, Milamis, Eeel-river, Weea's, Kickapoos, Piankashaws, and Kaskaskias.

To put an end to a destructive war, to settle all controversies, and to restore harmony and a friendly intercourse between the said United States, and Indian tribes; Anthony Wayne, major-general, commanding the army of the United States, and sole commissioner for the good purposes above mentioned, and the said tribes of Indians, by their Sachems, chiefs and warriors, met together at Greenville, the headquarters of the said army, have agreed on the following articles, which, when ratified by the President, with the advice and consent of the Senate of the United States shall be binding on them and the said Indian tribes."

Omitting now from Article I to the middle of Article III.

"And for the same consideration, and as evidence of the returning friendship of the said Indian tribes, of their confidence in the United States, and desire to provide for their accommodation, and for that convenient intercourse which will be beneficial to both parties, the said Indian tribes do also cede to the United States the following pieces of land, to with the United States the following pieces of land, to with the United States of land, the U

lowing pieces of land, to-wit: * *

(14) One piece of land six miles square at the mouth of the Chikago river, emptying into the southwest end of Lake Michigan, where a fort formerly stood.

(15) One piece twelve miles square at or near the mouth of the Illinois river emptying into the Mississippi.

(16) One piece six miles square at the old Piorias fort and village, near the south end of the Illinois lake on said Illinois river.

And the said Indian tribes will allow to the people of the United States a free passage by land and by water, as one and the other shall be found convenient, through their country, along the chain of posts hereinbefore mentioned.

Again, from the mouth of Chikago to the commencement of the portage between that river and the Illinois,

and down the Illinois river to the Mississippi. And the said Indian tribes will also allow to the people of the United States the free use of the harbors and mouths of rivers along the lakes adjourning the Indian lands, for sheltering vessels and boat and liberty to land their cargoes where necessary for their safety.

In testimony whereof the said Anthony Wayne and the sachems and war chiefs of the beforementioned nations and tribes of Indians, have hereunto set their hands and

affixed their seals.

Done at Greenville, in the territory of the United States, northwest of the river Ohio, on the third day of August, one thousand seven hundred and ninety-five."

LETTER OF PRIDEAUX SELBY TO PETER RUSSELL,

In Volume 18 of the Wisconsin Historical Collections, at page 458, there appears a letter from one Prideaux Selby to Peter Russell. Prideaux Selby, according to Note No. 80 was Assistant Secretary of the Indian Department at Detroit from 1790 to the evacuation. He then removed to Sandwich, where he remained until his headquarters were removed (1807) to York. In 1812 he was a member of the council of Upper Canada." The passage appears on page 459, and is as follows:

"That the Barrier which the United States presents is of so high a consideration unless the people of Kentucky and of the Ohio should join our enemies or permit them to pass unmolested through their North Western Territory, little danger to this Province is to be apprehended by that Rout. But that the water communication by the Ouisconsin to Lake Michigan (except an inconsiderable carrying place between that and Fox river) opens an easy passage for the introduction of Troops and all manner of stores either by the way of Chicago or Missilimackinac.

That the route by the Illinois river tho' much nearer, does not afford such advantages for bringing forward supplies as the Ouisconsin and altho' in the Spring of the Year the waters are always high by the dissolving of the Snow and frequent rains at that season, yet it is presumed that swelling of the Illinois may have subsided before an army could be in readiness to take the advantage of that circumstance and it must be observed also that there are many interruptions on this communication

such as Rapids and Shallow waters. The Ouisconsin therefore appears their most (best rout as it is the easiest and most secret as well from its distance from anybody of traders as from the little intercourse we have with the Indians inhabiting that part of the Country."

Communication from Albert Gallatin, Secretary of the Treasury, to the Senate of the United States, April 6, 1808.

(Prof. Alvord continuing):

Whereupon counsel for the government offered in evidence a communication from Albert Gallatin, Secretary of the Treasury, to the Senate on April 6, 1808. The document is found on page 724 American State Papers, Documents, Legislative and Executive of the Congress of the United States from the First Session of the First to the Second Session of the Tenth Congress, inclusive. Commencing March 3, 1798, and ending March 3, 1809. Selected and edited, under the authority of Congress, by Walter Lowrie, Secretary of the Senate, and Walter A. Franklin, Clerk of the House of Representatives. Published by Gales and Seaton, 1834; the document being dated April 4, 1808, and being communicated to the Senate April 6, 1808; which passage so offered in evidence, was as follows:

"III. Niagara.

The fall from Lake Erie to Lake Ontario has already been stated at four hundred and fifty feet. A company had also been incorporated by the State of New York for the purpose of opening a canal at this place; but it does not appear that anything was attempted after the survey had been made. The intentions seems to have been to open a canal navigation for boats only from Fort Schlosser to Devil's Hole; the lake itself and Gile's Creek would have supplied the water, and the expense was estimated at four hundred and thirty-seven thousand dollars.

It is, however, evidence that the canal, in order to be as eminently useful as the nature of the undertaking seems to require, should be on such scale as to admit vessels which can navigate both lakes. Considering the distance which in that case must be extended to about ten miles, and the lockage of four hundred and fifty feet,

it is not believed that the expense can be estimated at less than one million of dollars.

The papers relative to these communications will be found under the letter B. But their utility will not be confined to the extensive navigation of the lakes themselves; for the mountains being completely turned when arrived into Lake Erie, the ridge which separates the waters emptying into that and into Lake Michigan from the northern branches of the Ohio, and from the waters of the Mississippi is of a moderate elevation, and is gradually depressed in its course westwardly. There is no doubt of the practicability of opening canals, at a future period, between several of those waters either by selecting proper levels or by means of short tunnels across favorable parts of the ridge. It will at present be sufficient to point out the principal communications now in use.

The Illinois river, which empties into the Mississippi above St. Louis, rises in a swamp which, when the waters are high, affords a natural canoe navigation to the sources of Chicago Creek a short stream, which falls into Lake

Michigan at its southern extremity.

Another communication generally used by the Indian traders is that from Green Bay, also in Lake Michigan, to the Mississippi by Fox River and the Wisconsin. Nor is there any doubt that, if the inland navigation between the North river and the lakes was completely opened, the whole Indian trade either of the Mississippi by Lake Michigan, or of the northwest by Lake Superior, must necessarily center in an Atlantic port of the United States-a consideration of minor importance as a commercial object, when compared with the other advantages of that great communication, but of great weight in its relation to the political intercourse of the United States with the Indians."

FORSYTHE'S MEMORANDUM OF DISTANCES.

(Prof. Alvord continuing):

Thomas Forysythe was a fur trader; he was born in 1771 at Detroit and entered into the Indian fur trade in 1793. In 1809 he settled at Peoria; two years later he was Justice of the Peace of St. Clair County. In 1818 he became Indian Agent for the Missouri Territory. He was very familiar with the whole region of Illinois and the countries bordering on the Mississippi, both as a fur trader and afterwards as Indian Agent. He died in 1833. These papers are now in the possession of the Wisconsin Historical Society and form one of their most valued collections.

The said copy is as follows (Forsyth Papers-Wis. Hist.

Soc.):

"Reuben Gold Thwaites, secretary and superintendent of the State Historical Society of Wisconsin, at Madison, Wisconsin, being duly sworn testified that the following is a true and correct copy from a manuscript which has for many years past been in the possession of said society, entitled 'memorandum of distances as computed by voyagers, 1814,' and recognized by comparison to be the handwriting of Thomas Forsyth, who was for many year (including the said year 1814) the United States Indian Agent at St. Louis and elsewhere in the West; further that the press-mark of said manuscript in the library of the Society is '1T42' and is one of a collection known as 'Forsyth Papers.' Following is all of that portion of the manuscript that has reference to distances on the Illinois and Des Plaines rivers:

From Peoria to end	of	L	al	ke.											. 2
o Crow Prairie															
o Prue's Marsh															
to mouth of Vermi															
rapids															
o mouth of Fox Rive	er.						9 0	0	0 0	6					9
o Coal bark															
o falls												6			
o Nettle Creek										•		a			
To Sandy Creek						9				 9		9	a	9	
o Forks of Illinois															

From Forks of Illinois to Mount Julet	15
o dry trees	15
to the portage	15
across the portage	0
to Chicago	6
	60
a curation	
Total distance from St. Louis to Chicago by water but to go straight through the Prairies one-third of	400
this distance may be deducted	150
_	30

(Signed) REUBEN GOLD THWAITES.

Personally appeared before me this 24th day of June, 1910, the said Reuben G. Thwaites, to me well known as being the secretary and superintendent of the State Historical Society of Wisconsin aforesaid, and made oath to the correctness of the foregoing transcript and to the facts above set forth.

ANNIE A. NUNNS,
(Seal) Notary Public, Dane County, Wisconsin.
Commission expires August 27, 1911."

LETTER OF THOMAS FORSYTH.

Referring now to Volume 11 of the Wisconsin Historical Collections to which my attention is directed, at page 334, there is what purports to be a letter which is contained in a letter book of Thomas Forsyth, beginning on page 316. The explanation of this letter book with a biographical notice of Thomas Forsyth is contained in note 1 on page 316, which

note reads as follows:

"Major Thomas Forsyth had been for several years engaged in the fur trade,—on Saginaw bay at Chicago, on an island in the Mississippi near Quincy, and at Peoria,—and had acquired much influence over the Indians of Illinois, especially the Pottow ttomies, previous to his appointment as government Indian agent for the Illinois district, at the outset of the war of 1812-1815. His head-quarters were at Peoria. Upon the close of the war, he served as agent for the Sacs and Foxes, closing his official relations with them previous to the Black Hawk outbreak in 1832. In Wis. Hist. Colls., vi, p. 188 will be found a sketch of his career; and in the same volume (pp.

188-219), there are given the journal of his notable voyage from St. Louis to the falls of St. Anthony, in 1819 and a letter of his to Governor William Clark, of the same year. Further biographical material may be obtained in Scharf's Hist. St. Louis, pp. 1293, 1294; Reynold's Pion. Hist. Illinois (ed. 1887) p. 247; Hurlburt's Chicago Antiquities, pp. 469, 470, and miscellaneous references in Washburne's The Edwards Papers. In 1868, Major Forsyth's son, Robert, permitted the Society to make a complete transcript of his father's letter books covering the period, 1814 to 1825. The selections given in vol. vi. of these collections, above cited, are the only publications from these letter-books, thus far made. There are now selected such portions of the first book as refer to the war of 1812-15. They throw new light on this interesting period of our history, and are given in this volume, wherein the British operations are so fully set forth in the reports and letters of McDougall, McKay Dickson and Grignon, as showing the other side of the picture—the means adopted by the Americans to keep the Illinois Indians in line with our interests and prevent them co-operating with the savage allies of England. In this important work, Forsyth's services are shown to have been of great value.—Ed."

I find on page 334 a passage relating to the use of the

Chicago-Desplaines route.

The said passage referred to is as follows:

"There is a good deal of talk at present in this place about the British and Indians coming down to attack our frontiers this season, but this I cannot believe, without they had a sufficienty of regular troops to garrison the different places, at this place, Ste. Genevieve Kaskaskia, &c. It is true they might come down this season with a very large Indian army and carry fire and sword through our frontiers as they can at any time raise from three to four thousand Indians without including the Sioux, or the Mississippi or any of the Missouri Indians, viz:

Saukies & Foxes amounting to 1200, deduct 200 said now to be friendly in Missouri remains
Pottawattamies can furnish 1200 warriors but suppose one-half will not come if asked 600
Winnebagoes will come to a man
on's garde de corps
can be easily brought down by way of Chicago & the Illinois river
Kickapoos when altogether
perior
Total

Making an aggregate of thirty-six hundred on a very moderate calculation; nevertheless it does not appear to me that any invasion will be attempted this season, but if the reports are correct as respects Spain having declared war against us I should not be surprised if the Spaniards came down the Missouri by way of River Platte with a great body of Indians and perhaps the British at the same time may come down from the Mississippi or Illinois River, who will also bring down another body of Indians, by which means in indiscriminate massacre must take place, for let the British and Spaniards be ever so inclined to keep the savages from killing in cool blood, it will be out of their power from the great number of Indians they will bring with them."

LETTER OF LEWIS CASS TO SECRETARY OF WAR.

(Prof. Alvord continuing):

The Governor Cass referred to in the certified copy of certain papers of the office of Indian affairs in the Department of the Interior of the United States Government, to which my attention is called, was Governor of Michigan and naturally interested in stopping the monopoly which the subjects of Great Britain living in Canada had of the fur trade in the lake region, and this is a letter from the Governor which will speak for itself, in which he points out what must be done in order to develop the upper Northwest. As a part of that record there is a communication from John Kinzie. John

Kinzie was the first English speaking citizen of Chicago, living here for a great many years. He was a hard-headed trader seeking his own commercial advantages. He knew the upper Illmois region extremely well from personal experience, and has the indorsement of Governor Cass as to his knowledge and veracity. Kinzie was settled at Chicago for the purpose of trading with the fur traders, and also taking in their furs as they came to Chicago.

Whereupon there was offered in evidence a letter of Governor Cass to the Secretary of War, and the letter of John Kinzie to Governor Cass to which was attached a certificate from the Department of the Interior, certifying to their being

true copies of the original, as follows:

"Detroit, June 20, 1815.

Sir: I had intended by this time to have submitted to you a general view of the state of Indian affairs in the Country and of the measures necessary to be adopted to secure permanent tranquility upon the frontiers.

But so much of my time is engaged by applications and visits from the Indians that I find it impracticable to effect this object immediately. I am only able to submit to you the accompanying propositions, which are the result of my inquiries and which is adopted will I trust cause a salutary reform in the state of our Indian Relations.

The privilege which British traders have heretofore enjoyed of carrying on a lucrative commerce with the Indians is a subject which will doubtless engage the attention of the Govt. To this source may be traced most of the difficulties we have experienced in our intercourse with them, I have every reason to believe that the Indian Department opposite to us are about to adopt the same systematick course of measures, which they have so long and so successfully pursued but with renewed activity and increased exertion—A deputation of one influential Chief from each of the different tribes left Malden shortly since for the lower province and another follows in a few days. What their precise object is we have not yet been able to ascertain, but such enquiries are making as will soon disclose it to us. There is little doubt however, of its relating to a general systematick and vigorous organization of their Indian Department. In the meantime a large quantity of goods have arrived at Malden to be distributed as presents and the Agents and subordinate officers are more numerous than at any former period. These unerring indications give us timely warning that the same measures are to be adopted, the same lying system continued (pardon the epithey, could all the facts be presented to you, you would say no milder term could be used) and the same plan of filling out Indian Country with the agents and Interpreters and traders which have at all former periods kept the North

Western frontiers in a state of feverish alarm.

I am aware that the Government are compelled to view the whole ground and that it may become necessary to grant to the British the privileges heretofore held among the Indians in order to secure to our Country commercial rights more important to the nation at large. Is it with a view to such a possible event, that I submit these propositions to you. Their adoption will be found to counteract in a very considerable degree causes which have heretofore operated without any check.

Should it be found necessary in a treaty of commerce to make such a stipulation, the evil would be diminished by allowing to British subjects this privilege under the same restrictions it is granted to American citizens. This will secure to us the right of recalling them, when we find their machinations injurious or when their obvious purpose of trading is to cover a plan for scatter-

ing disaffection among the Indians.

There are three great channels of communication, by which traders may introduce the goods into the Mississippi and Missouri country from the British dominions. One is by the way of Chicago, and down the Illinois, another by way of Green Bay up the Fox River down the Ouisconsin. This has been the great thoroughfare along which goods have been taken: Immense quantities have been smuggled to the Mississippi and it is calculated that not more than one third part of those sold in the Indian Country, ever pay duties. The establishment of a post at Green Bay and at Prairie du Chien will close this line of communication. Another at Chicago will effect the same object upon the Illinois. There will, then remain a route to be taken, which has heretofore been little used. It is up a small river which enters Lake Superior near the Grand Portage and along a number of small lakes with portages to heads of the Mississippi. I am informed by intelligent men that this is the only route, after closing those by Chicago and Green Bay which is practicable. If the British traders are eventually to be excluded, a post near the Grand Portage will be necessary to effect this object. Should other considerations render their admission proper the post would still be necessary to ensure a collection of the duties and to enforce the regulations proper to be adopted. A display of the power of the United States in that remote quarter would be productive of salutary effects upon the minds of the Indians.

Should it be deemed proper to establish a post in that Country the previous arrangements should be made this fall in order that we may be ready to proceed at the

opening of the navigation.

I am inclined to believe if these posts are all established and proper regulations adopted at the various agencies, that British traders may be admitted without very serious inconvenience. Certain I am that their admission will not be attended with the same evils, which have heretofore been experienced.

Mr. Jouett the Agent for Green Bay has arrived here, he has been long acquainted with Mr. Kinzie whom I recommended to you for the appointment of Agent at Chicago, I have requested Mr. Jouett to address you

upon the subject.

Very respectfully Sir
I have the honor to be Yrs. etc. etc.
Directed to Hon. A. J. Dallas, Acting Secretary of War
Indian Off. Bk. 204, Letter Bk. 1 Pens. Bldg. p. 90)"

LETTER OF JOHN KINZIR TO GOVERNOR CASS.

"Detroit, 15 July, 1815.

To His Excellency Lewis Cass, Esq., Governor of Michigan Territory.

Sir:

Taking into consideration the importance of that section of Country, lying on the Southern extremity of Lake Michigan, to our Government and having been upwards of twenty years residence of that portion of United States acquired a knowledge of its importance, I thus take the liberty of laying my observations before you. The executive of the United States appears anxious to establish a peaceable and friendly intercourse with the Indian tribes, the most determinedly hostile are the Chippewa, Pottawattomies, Ottawa of L'arbre Croche, and the Winnebago tribes, who inhabit the country between the Southern

extremity of Lake Michigan and Michillimackinac, and whose chief residence is upon Grand and Muskeegon rivers, but, who from the want of a proper supply of game, are compelled to emigrate at certain seasons to the waters of Chicago, Illinois and Fox Rivers. The hostility of those tribes is owing to their intercourse with the traders of S. W. Company, whose intercourse and of course whose policy is to render them inimical to all American traders, from what I have already said the importance of establishing a military post at or near the place of their general rendezvous will at once present itself the spot which is most important and which will possess the greatest advantages is that on which Fort Dearborn formerly stood as those tribes generally rendezvous there in the Spring consequently a garrison would be necessary to reduce trade and intercourse with them to a system and to prevent frauds and misrepresentations from the agents of another government whose interference will ever keep them hostile to the United States.

As the navigation of those waters will in a few years become an object of great importance to the U. States as at present boats of several tons burthen can pass from Lake Michigan into the Mississippi River there being only four, and half feet difference in the elevation of the two waters. Therefore it would be politick to adopt measures in due time that will secure the friendship of the hostile and fix that of the wavering. A judicious system of policy will in a few years effect more towards conciliating the tribes that are hostile than a long expensive exterminating war, and intercourse with the savages is absolutely necessary, Garrisons to protect trade and create respect for agents are equally so. Agents should act with the most impartial justice and should administer to their little wants the supplies they have been long in the habit of receiving from the British Government. While the citizens of the U. States are kept at such a distance from these tribes, and their trade so confined from the want of the arm of protection being extended over it and the intercourse of the foreign merchants (who bear away nine tenths of that important trade) allowed the American can do no other than submit in silence or coincide with the consummate and intriguing British trader or perhaps his scalp may be paid for and he fall victim of the hatchet it he has the temerity to support his country.

The only means to do away the mistaken animosity of the tribes is by the proper application of small presents to the chiefs a mild and conciliatory conduct to the nation at large and by keeping such an armed force in their neighborhood as will awe medling intruders into silence.

Chicago is all important to the Illenois country as it is the key of communication and has command of the trade a vast territory and whose navigation serves to forward the returns of the merchant to Michillimackinac at a much lower rate than they can at present be forwarded by the Mississippi owing to the difficulty of procuring boats. The Coal and Lead mines will when protected by the arm of authority become very important to this frontier as all transportation from them may be made by water.

The calling the above named tribes to Green Bay to receive annuities or other gratuities that may be granted them by the Government or to trade at that Factory will be attended with very little benefit unto the tribes mentioned, as the distance is great, the face of the country one continued morass and in the winter season impassable by the traveller owing to the depth of the Snow, therefore those tribes will suffer if they have to depend on the Agency or factory at G. Bay.

The above statement you may rely is correct. Having resided many years in the Country as an individual, I have combatted in trade against the whole Michillimackinac or S. W. Company and have many years employed a Vessel for my return furs to Detroit. I mention this to show you the importance of the Trade of the Chicago Country if correctly managed.

I am Your Excellency's Most obt. Servt.

JOHN KINZIE."

TREATY WITH INDIANS, AUGUST 24, 1816.

The government thereupon introduced in evidence an extract from the treaty of August 24, 1816, found in volume 39, Senate Document No. 319, Indian Affairs, Laws on Treaties, Second Edition, Volume 2, the treaty having been concluded between Ninian Edwards and others, the commissioners plenipotentiary of the United States, on the one side, and the tribes of Ottawas and so forth, on the other side.

Said portion referred to is as follows:

"Whereas a serious dispute has for some time past existed between the contracting parties relative to the right to a part of the lands ceded to the United States by the tribes of Sacs and Foxes, on the third day of November one thousand eight hundred and four, and both parties being desirous of preserving a harmonious and friendly intercourse, and of establishing permanent peace and friendship, have, for the purpose of removing all diffi-

culties, agreed to the following terms:

Art. I. The said chief and warriors, for themselves and the tribes they represent, agree to relinquish, and hereby do relinquish, to the United States, all their right, claim and title, to all the land contained in the before mentioned cession of the Sacs and Foxes, which lies south of a due west line from the southern extremity of Lake Michigan to the Mississippi River. And they moreover cede to the United States all the land contained within the following bounds, to-wit: beginning on the left bank of the Fox river of Illinois, ten miles above the mouth of said Fox river; thence running so as to cross Dandy creek, ten miles above its mouth, thence, in a direct line to a point ten miles north of the west end of the Portage, between Chicago creek, which empties into Lake Michigan, and the river DesPlaines, a fork of the Illinois; thence, in a direct line to a point on Lake Michigan ten miles northward of the mouth of Chicago river; thence along the lake to a point ten miles southward of the mouth of said Chicago creek; thence, in a direct line, to a point on the Kankakee, ten miles above its mouth; thence, with the said Kankakee and the Illinois river, to the mouth of Fox river, and thence to the beginning: Provided, Nevertheless That the said tribes shall be permitted to hunt and fish within the limits of the land hereby relinquished and ceded, so long as it may continue to be the property of the United States.

In witness whereof, the said Ninian Edwards, William Clark and Auguste Chouteau, commissioners aforesaid, and the chiefs and warriors of the aforesaid tribes, have hereunto subscribed their names and affixed their seals, this twenty-fourth day of August, one thousand eight hundred and sixteen, and of the independence of the United States the forty-first."

DARBY'S TOUR WITH EXTRACT FROM THE ST. LOUIS ENGINEER,

(Prof. Alvord continuing):

This book which is now shown me is entitled "A Tour from the City of New York to Detroit in the Michigan Territory, made between the 2d of May and the 22d of September, 1818, by William Darby, Member of the New York Historical Society. Author of a Map and Statistical Account of Louisiana;

and Emigrant's Guide. New York, 1819."

William Darby was a very well known writer of that period, published quite extensively. He was a surveyor and was employed in 1818 by the United States and commissioned to run the line between Canada and the United States. Previous to that he had lived for many years in Louisiana, and it was after his residence there that he published his statistical account of Louisiana. He was particularly interested in opening up the trade of the West and was regarded by contemporaries as one of the authorities on the possibility of western trade. He was very much interested in the opening up of the Erie Canal which was to assist New York in getting her share of the western trade; and for similar reasons those merchants of New York that were interested in securing the trade, corresponded with him and talked with him about the possibilities of extending their trade farther westward, so that he investigated the conditions of the far west with the purpose of advancing the trade of the eastern colonies.

He himself was very broad minded, he did not feel that the opening up of the west should depend upon the interests of any particular state such as New York, but that the interests of all were the same; that the advantages which might accrue from opening up water routes into the west or road routes, must be based upon the common interests of all the people of the United States and the people of the west.

I find in that book a reference to the river route by way of the Chicago and Desplaines river in addenda No. 2, page xxvll, as follows:

(Darby's Tour. Add. No. 2. p. xxvll.):

"The foregoing correspondence and extracts, contains the substance of my own personal observations, and such explanatory matter from others, as I could collect during my tour, and since its termination; I cannot, however, take leave of the reader, without claiming his patience during a recapitulation, and an examination of some extraneous matter, which was not included in my original letters, though of some importance to elucidate the topography of the country over which I ranged. I am aware that such productions as mine; where few personal incidents were introduced, must draw their interest from the geographical information they may contain. It has been my endeavor to throw as much light as in my power, upon the natural structure, and present improvements of the tract over which I ranged; how far I have succeeded, is now before the reader. There is one object of general interest upon which more is perhaps expected from me than I can fulfill; that is, the Grand Canal now in progress in the state of New York. On the subject of this truly great work, I have been careful to collect all the information I could procure, and have now presented the result to the public. Not having visited Ballston or Saratoga Springs, I addressed a letter to the Rev. Reuben Sears, desiring that gentleman to give me such information as he possessed, respecting these places of public resort. Mr. Sears very politely and satisfactorily replied to my letter; his answer I have annexed to this Addenda confident that it contains much valuable statistical matter.

In my letter to Mr. C. C. Haines, I have explained my views of the connexions that nature seems to have designed between New York and Pennsylvania, and can add but little in this place to what I then stated. From the demonstrations I have given of the true respective levels, between the head waters of the branches of Ohio river and those which flow into Lake Erie, the formation of water communication between these streams must be attended with great difficulty. We will now proceed to examine some of the various intended channels of intercommunication between the Mississippi and St. Lawrence vallies, and also the routes of the two New York canals.

No doubt now remains but that the Chicago and Illinois rivers, afford by far the most eligible natural connexion between the northern and southern waters of the United States. It appears that the great spine running from the Hudson to the Maunee river, terminates at, or is interrupted by the valley of the Illinois. The latter stream is formed towards its source by two branches, one of which rises south of lake Michigan and the other (river Plein) rises in the flat country west of the Chicago and flowing south, unite to the southwest of the extreme south part of Michigan. The Chicago heads in the same plain

with the river Plein and winding for some distance parallel to the latter stream, thence turns east, falls into lake Michigan. The Chicago and Plein intermingle their sources, and afford one of those instances where rivers have their sources in plains, so nearly approaching the curve of a real sphere as to leave for the discharge of the waters scarce inclination sufficient to determine their courses. This is the case with the two rivers we are now reviewing. The precise descent of the Chicago, from its nearest approach to the Plein, to the level of Lake Michigan has never been ascertained but it is known to be without falls, or even rapids. The Plein also flows with a very slight current and the two streams present almost a strait between the Mississippi river and lake Michigan."

At this point there is the following foot note:

"The following interesting notice, decides the long contested problem of a natural water communication between the waters of the St. Lawrence and Mississippi rivers, and contains also some other items of valuable information.

From the St. Louis Enquirer.

Communication with the lakes. Messrs. Graham and Phillips, commissioners on the part of the United States, and Mr. Sullivan, surveyor have set out to Lake Michigan to mark the boundary lines of the lands ceded to the United States by the Ottawa, Chippewa, and Pottawattima Indians in the summer of the year 1816.

They will run a line from the southern extremity of

this lake to the Mississippi.

The Indians have ceded to the United States what lies

to the south of this line.

The commissioners will run two other lines from the southwestern part of Lake Michigan, to the Illinois river. The lines will be parallel to each other, and twenty miles apart. They will begin in the shore of the lake at points ten miles north and south of Chicago and will embrace the little rivers Chicago and Plein and the carrying place between them, which form the channel of communication between Lake Michigan and the Illinois river. The Indians have ceded to the United States this important pass with ten miles of country on each side of it and it is the business of the commissioners to mark out the limits of

the grant that the American government may reduce it to

possession.

The communication between the lake and the Illinois is a point which will fix the attention of the merchant and the statesman. They will see in it the gate which is to open the northern seas into the valley of the Mississippi and which is to connect New York and New Orleans by a water line which the combined navies of the world cannot cut off. Never did the work of nature require so little from the hand of art to complete so great a design.

The Lakes Superior, Huron, Erie and Ontario lie from west to east in the direction of the St. Lawrence, manifestly seeking their outlet through the valley of that river. But the Michigan departs from that direction; she lies from north to south. United to the other lakes by a strait, she stretches the body of her water down toward the head of the Illinois river, as if intending to discharge herself through that channel into the Mississippi. no hills or mountains intervene to prevent the conjunc-On the contrary, the ground between is flat and covered with ponds in wet weather, which turn their waters partly to the lake and partly to the river. Chicago and the Plein are the drains from these ponds; they have neither falls nor shoals; they have not the character of streams but of canals; the water hardly moves in their deep and narrow channels. The Illinois itself is more a canal than a river, having hardly current enough to bend the lofty grass which grows in its bed. The French of Canada and of the Valley of the Mississippi have communicated through this channel since the settlement of the countries. In high water, boats of ten or a dozen tons pass without obstruction. In dry season they are unloaded placed on vehicles and drawn by oxen over a portage of a few miles, and launched into the river or lake as the course of the voyage may require. Hundreds nay thousands of boats have been seen at St. Louis, which had made a similar passage.

The land contiguous to this important pass was ceded to the United States by the savage tribes who formerly possessed the right of soil. The land thus ceded, is now about being surveyed, and in course will ere long be sold to individuals and settled. The development of the natural resources of this region will be disclosed with the ordinary celerity, that marks the newly established settle-

ments in our western world.

The course of Lake Michigan contributes in some measure to diminish the natural advantages of its connexion with the Illinois. The mouth of the Calumet River, or southern part of Lake Michigan, is near N. Lat. 42; whilst the straits of Michilimackinac is about 45 degrees, 40 minutes, making a difference of latitude of three degrees forty minutes. This difference of geographical position exposes the two extremes of Lake Michigan to great variety of climate; the navigation of the northern parts being annually and of the southern frequently impeded by ice. I have annexed to this Addenda, tables which will exhibit the relative distance from the City of New York to St. Louis by the Canadian Lakes and by the Chio River. These routes, however, are so different from each other in climate, facilities and impediment, that very little accurate induction can be drawn from their respective length to determine a preference.

It can scarcely be doubted, but that beyond Buffalo when the contiguous countries are equally inhabited, the Illinois river and Canadian Lakes will form the channel of communication with the upper waters of the Mississippi in preference to the route by the Ohio. The navigation of the latter river is subject to great embarrassment from frost and long dry weather in the fall season. So much of the northern channel of commerce permits the use of vessels of considerable tonnage, that transportation from Buffalo to Chicago, will be less expensive than that of any equal distance by the Ohio route. If the people of the United States ought to ever unite, in opening a channel of communication it is that by the Illinois river and Lake Michigan. If the various points from St. Louis to Buffalo were united by commercial facility, a numerous population would be the immediate consequence. a population that would spread a shield before the interior parts of our country and would give a preponderance upon the St. Lawrence waters to the people of the United States, which in future wars would prevent a repitition of some of the disastrous events of the late contest with Great Britain."

REPORT OF MAJOR STEPHEN H. LONG.

(Prof. Alvord continuing):

Referring to the State papers of the First Session of the 16th Congress, and particularly to a report of Major Stephen

H. Long to the Secretary of War, I would say that Major Long was in charge of the expedition to investigate the practicability of waterways and particularly the use of this water course, Chicago and Desplaines, and has made a very careful report based upon observation. I am familiar with the publication of these various state papers and the facts with reference to their compilation and publication. They are the publications of the various reports and documents that are laid before congress.

The said report from Stephen H. Long is as follows:

"Department of War

28th December, 1819.

Sir: In compliance with a resolution of the House of Representatives of the 15th inst., directing the secretary of War to lay before that house the several topographical reports that have been made to the War Department, in pursuance of instructions to that effect, respecting the practicability of uniting by a canal the waters of the Illinois river and those of Lake Michigan, and such other information as he may be in possession of on that subject, I have the honer to transmit an extract of Major Long's report, and a copy of a report made by R. Graham and Joseph Philips, Esquires, which comprehend all the information on the subject in this department.

I have the Honor to be Very respectfully, Sir,

Your most obedient Servant

J. C. CALHOUN.

Hon. Henry Clay, Speaker of the House of Representatives, U. S.

"Extract from a report of Major Stephen H. Long to George Graham, Esq., Acting Secretary of War, dated

Washington, March 4, 1817.

The Illinois is formed by the union of three considerable rivers, the Des Planes, the DePage and the Kankakee, the last of which is nearly double the size of either of the two former. The Illinois is about three hundred miles in length and is of variable width from 70 yards to one mile. It has a very moderate current and a depth of water sufficient to render it navigable, at all time, for boats of considerable burden about 230 miles from its mouth. At the mouth of the Vermillion there are rapids, perceivable only

in the lower stages of winter. Farther up the water is not

generally so deep as it is below the Vermillion.

The Valley of the Illinois varies in its width from three to ten miles; is, generally, flat and marshy, and, for the most part, subject to inundation, when the river has no more than a medial height. In some parts of it, however, prairies and bottoms of considerable extent are to be met with, elevated much above high water mark. In ascending the river, the bluffs, gradually decrease in height, being about 150 feet high at the mouth and about 100 feet at the head of the river. Imbedded in the bluffs, are strata of limestone, slate and coal, which, occasionally make their appearance along the surface of the declivities.

The river DesPlanes is a small stream rising in the lowlands, bordering upon the west side of Lake Michigan and has its general course in a southwesterly direc-The Valley of this river has an average width of about one mile and is terminated on both sides by regular banks nearly parallel to each other, extending along the river about thirty miles from the head of the Illinois. In ascending this river, also the banks and bluffs gradually decrease in height being as before mentioned about one hundred feet high at the mouth and only 100 or 125 at the distance of 30 miles higher up the river, where, instead of maintaining their parallel direction, they form nearly right angles with the course of the river, that on the right taking an easterly, and that on left a northwesterly course; but, being gradually inflected from these courses, they form extensive curves encircling a large tract of flat prairie, in no part elevated more than 12 or 14 feet above the common level of the water in this vicinity. The river. throughout the above mentioned distance has four or five short rapids or ripples that make their appearance only in times of low water. In every other part it has the appearance of being a chain, of stagnant pools and small lakes, affording a sufficient depth of water for boats of moderate draught.

In the flat prairie, above mentioned, is a small lake, about 5 miles in length and from 6 to 30 or 40 yards in width, communicating both with the river DesPlaines and Chicago river by means of a kind of canal which has been made partly by the current of water, and partly by the French and Indians for the purpose of getting their boats across in that direction, in time of high water. The dis-

tance from the river DesPlanes to Chicago river by this water course is about 9 miles through the greater part of which there is more or less water, so that the portage is seldom more than three miles in the driest season, but in the wet season boats pass and repass with facility be-

tween the two rivers.

The rivers DePage and Kankakee bear nearly the same character in regards to their bluffs, valleys, &c., that has been given to the DesPlanes. The former of these rivers takes its rise a few miles west of that of the DesPlanes and has a course nearly parallel with it. The latter rises in a flat marshy country in the neighborhood of the St. Joseph of the Lake, and runs meandering course westwardly passing the southern extremity of Lake Michigan at a distance of 20 or 30 miles from it. Near the head of this river is a small creek falling into St. Joseph, through which boats have passed in time of high water from the St. Joseph to the Kankakee. The country through which the DesPlanes, DePage and the Kankakee rivers take their course, appears to be underlaid with a vast bed of limestone which occasionally makes it appearance in the valleys of those rivers, covered with a soil too

thin to support vegetation.

Chicago river is merely an arm of the lake dividing itself into two branches, at the distance of one mile inland from its communication with the lake. The north branch extends along the western side of the lake about 30 miles and receives some few tributaries. The south branch has an extent of only 5 or 6 miles, and receives no supplies except from the small lake of the prairie above described. The river and each of its branches are of variable widths, from 15 to 50 yards, and, for two or three miles inland have a sufficient depth of water to admit of almost any burden. The entrance into lake Michigan, however, which is 30 yards wide is obstructed by a sandbar about 70 yards broad, upon the highest part of which, the water is usually no more than two feet The difficulty of removing this obstruction would not be great. Piers might be sunk on both sides of the entrance and the sand removed from between them. By this means, the river would be rendered safe and commodious harbor, for shipping, a convenience which is seldom to be met with on the shores of Lake Michigan.

The St. Joseph of the Lake is navigable to batteaux, to a very considerable distance in all stages of the water.

The St. Joseph and St. Mary's of the Maumes are rivers of considerable size and extent. The latter in wet seasons is navigable for perogues to fort St. Mary's, 150 miles from its confluence with the former, by the course of the river. Its branches interlock with those of the Wabash and Big Miami. The St. Joseph is navigable about 50 miles, its tributaries interlocking with those of the St. Joseph of the Lake, the Kankakee and the Wabash. The Maumee of the Lake is one hundred miles in length and is navigable for batteaux and perogues throughout its whole extent in all stages of water; about 30 miles above its mouth are the Wolf Rapids. The face of the water, however, is not so great as to occasion any very serious obstruction to the navigation of the river. The courses and relative positions of the several rivers and creeks may be seen by recurring to the plans.

Proposed Canals and Roads.

A canal uniting the waters of the Illinois with those of Lake Michigan, may be considered the first in importance of any in this quarter of the country, and, at the same time, the construction of it would be attended with very little expense compared with the magnitude of the object. The water course which is already opened between the river DesPlanes and Chicago river needs, but little more excavation to render it sufficiently capacious for all the purposes of a canal. It may be supplied with water at all times of the year, by constructing a dam of moderate height across the DesPlanes, which would give the water of that river a sufficient elevation to supply a canal extending from one river to the other. It would be necessary also, to construct locks at the extremities of the canal that communicating with Chicago river being calculated to elevate about six feet, and that communicating with the DesPlanes about four feet,

To render the DesPlanes and Illinois navigable for small boats and flats requiring but a small draught of water, nothing more is necessary than the construction of sluices, in a few places where there are ripples of a sufficient width to admit the boats to pass through them. This may be effected by clearing away the loose stones from the bottom and forming banks rivited with stones two or three feet high on each side of the sluices, thus, the water communications between the Illinois and Lake Michigan may be kept open at all time sufficient to answer all the purpose for which a canal will be wanted for many years to come. A canal uniting the St. Joseph of the lake with the Illinois by way of Kankakee may be constructed also in a similar manner, and with great facility, except that the distance by this route is con-

siderably greater.

There are various other places where water communications may be opened in this quarter by means of canals, to great advantage, of which the following are but a small proportion, viz; between the St. Joseph of the Lake and the St. Joseph of the Maumee; between the latter and the Wabash and between the Illinois and the Wabash by way of the Sangano river. A canal also uniting the Mississippi and Ohio, a little above their junction would be a great public utility, particularly should a general depot for military stores be established near the mouth of the latter. The objects of this canal would be to shorten the distance by water from the contemplated site of the depot, northwardly, to avoid a part of the Mississippi, difficult to navigate, and to render the depot accessible by an easy and safe communication both from the Ohio and the Mississippi."

REPORT OF R. GRAHAM, ASSISTANT SECRETARY OF WAR, AND JOSEPH PHILIPS, CHIEF JUSTICE OF ILLINOIS.

(Prof. Alvord continuing):

The next report attached to this same document is the report of R. Graham and Joseph Philips. Philips was one who accompanied this expedition of Major Long and made a report likewise on the subject. He was the first Chief Justice.

The said report of Graham and Philips is as follows:
"Kaskaskia, April 4th, 1819.

Sir: In addition to the notes of Mr. Sullivan, the surveyor, which describes the face of the country over which the lines were run, we beg leave to suggest some views which occurred to us in the subject of communications between the river Illinois and the Michigan Lake.

By reference to the map herewith forwarded, it will

be seen that the little river Plein coming from the northwest approaches within ten miles and a quarter of Lake Michigan, and then, bending to the southwest, unites with the Theakiki at the distance of about 50 miles, and forms the river Illinois.

The country between the Lake and the Plein at this point of approach, is a prairie (natural meadow) without trees covered with grass, and, to the eye, a perfect From the bank of the Plein standing on the ground, the trees are distinctly seen, with the naked eye, at Ft. Dearborn on the shore of the Lake; from Ft. Dearborn they are in like manner, seen on the bank of the Plein. Standing on any intermedeate point between the lake and the river and the judgment is at a loss to say which side the ground declines and whether the level

of the Plein or the lake is the highest.

It was, however, determined, from certain data, that the level of the river was two feets, or thereabouts, above the level of the lake. From this view it would seem that the cutting of a canal in this place between the Plein and the Lake would be a work of neither skill, difficulty or expense. Small, however, as the labor would be under this view it is still diminished upon a close examination, and by finding that an arm of the lake called Chicago puts out in the direction of the Plein and that an arm of the Plein, also called Chicago, puts out in the direction of the lake. They approach within two miles of each other; so that, in common water, there is only dry ground to that extent between them. The character of these two arms is essentially different; that of the lake being about sixty feet wide, and from ten to forty feet deep; that of the river, being in high water, from four to six feet deep, and in, places a mile wide, and, in low water, either dry or reduced to a gutter. Between the heads of these two arms is also a gutter, which is dry in the dry seasons of summer and fall, and full of water in the spring, and, when thus filled with water, the boats, of six or eight tons, engaged in the Mackinaw and Mississippi trade, run through, backwards and forwards, so as to make no portage between Mackinaw and the Mississippi. This gutter, judging from the appearance of others now forming, was, at first, a path worn out by the feet of those who carried things across the portage, and afterwards deepened by the attrition of the waters until formed into

a little canal. The wind, alone, gives the water a current in this little canal, and its direction depends upon the course of the wind. Objects have been seen to float out of it from the same point to the river and to the lake.

It is incontestibly true, that an east wind will drive the water of the lake through this gutter into the Plein, and that water from Lake Michigan has been discharged by this outlet into the Mississippi, and thence into the Gulf of Mexico. It is equally incontestible, that the waters of the Plein have been driven, by the same channel, into the lake; and these phenomena may now be witnessed, at any time, when the waters are high and the wind blows hard. It follows, therefore, that to finish the canal began by nature, in this place, would require, as we have already said, but little of skill, time or expense. On opening the canal, however, two difficulties would be experienced.

1st. The Plein would be found to be above the level of the canal; its water, of course, would be diverted from its natural channel, and pass by the canal into the lake.

2d. Supposing that evil remedied by a lock to lift vessels into the Plein, yet the Plein during half of the year does not contain water enough to float a boat, and so could not become useful as a national highway.

To remedy this defect of water in the Plein two projects suggest themselves: 1st. To sink the bed of the Plein below the level of the canal and thus increase the depth of the Plein as well by feeling it out of the lake, as by collecting its water into a narrower channel. 2d. To make the canal unite with the Plein lower down in its course. A few miles lower would be sufficient to give the water of the lake a descent into the river, as the Plein has a sensible descent in this place, inasmuch that the people of Chicago, call it "The Rapida" having no other word to distinguish moving water from that which stands still. Of the Plein below its point of approach to the lake, we would remark, that it has hardly the attributes of a river, being in most places without current, and without banks lying as a sheet of water in the Prairie, some times a mile wide, and so shallow that the tall grass appears almost everywhere above its surface. Having said thus much of the facility of communication by the Chicago, we would now remark that several other routes are perfectly practicable. 1st. From a point in the lake

south of Chicago to enter the Plein below mount Juliet. at or near that is called lake du Page, but which is only a dilation of the waters of the Plein. This route would lay over level Prairie, through a multitude of small lakes or ponds, which have neither name or place in any map. 2. By a canal leaving the lake near its south end, and uniting with the Theakiki, just above its confluence with the Plein. Both of these canals would be fed from the lake, would require few or no locks, would go over ground of the same sort, would be 50 or 60 miles long, and would join the waters of the Illinois at points from which it is constantly navigable. A third route was spoken of, but not seen by us. It would lie between the Theakiki and the St. Joseph of the lake. Information says that it has been practiced by French traders. You will perceive, sir, that we have not spoken of the nature of the soil through which these several routes would pass. Not being our business to search for, and report upon the practicability of water communication, our observations were limited to what fell under the eye while engaged in another duty, and in making this report to you, it is our object to excite inquiry not to furnish plans of practicable projects. We shall, therefore, only say, on this point that the country, in general, and the bed of the Plein exhibited much loose stone and pebble, and firm

To conclude, the route by the Chicago, as followed by the French since the discovery of the Illinois, presents at one season of the year an uninterrupted water communication for boats of six or eight tons burthen, between the Mississippi and the Michigan lake; at another season, a portage of two miles; at another, a portage of seven miles, from the bend of the Plein to the arm of the laek; at another, a portage of fifty miles, from the mouth of the Plein to the lake, over which there is a well beaten wagon road, and boats and their loads are hauled by oxen and vehicles kept for that purpose by the French settlers

at the Chicago.

Respectfully,

Your obedient servants,
R. Graham
(Signed) Joseph Philips."

To Hon. J. C. Calhoun, Secretary of War, Washington." ENTRIES IN THE JOURNAL OF THE AMERICAN FUR COMPANY.

(Prof. Alvord continuing):

In Volume 12 of the Wisconsin Historical Society Collections, at page 154, which is now shown me, I find a list of the employes of the American Fur Company of 1818. On page 162 I find the following entry: "Engaged April 28, 1818. Hubbard, Gurdon S. Time, five years. Capacity, Clerk. Where engaged, Montreal. Wages \$120. Where employed,

Illinois river. Remarks Illinois River."

On page 376 of Volume 11 of the Wisconsin Historical Society Collections now shown me I find a list of invoices of the American Fur Co. On page 370 the following entry: "Accounts American Fur Company. Invoices 1821-2." On page 377 under a heading found on page 375: "For Account and Risk American Fur Company," there is this entry: "Antoine Deschamps & Gurdon S. Hubbard for the trade of the Iroquois River and its dependencies, Michilimackinac, Aug. 9, 1822."

ACCOUNTS OF GURDON S. HUBBARD OF HIS YEARLY TRIPS UP AND DOWN THE ILLINOIS AND DESPLAINES RIVERS, 1818-1824.

The book now shown me is entitled "Gurdon S. Hubbard, Sketch of Life, 1802-1886." It is further entitled "Incidents and Events in the life of Gurden Saltonstall Hubbard. Collected from Personal Narrations and other sources, and ar-

ranged by his Nephew, Henry E. Hamilton, 1888."

Mr. Hamilton was a nephew of Mrs. Hubbard, and lived with the Hubbards as their son. He had collected all possible data concerning his uncle and has published it in this volume, with many quotations from the Hubbard manuscript. I find in that book references to the nature of the trade in which Hubbard was engaged and the routes which were used by him on pages 39, 43, and 59-60. This account is based upon Hubbard's own narrative.

The passage on page 39 is as follows:

"After a few days at Chicago spent in repairing our boats, we struck camp and proceeded up the lagoon, or what is now known as the South Branch, camping at a point near the present commencement of the Illinois and Michigan Canal, where we remained one day preparing to pass our boats through Mud Lake into the Aux Plaines River.

Mud Lake drained partly into the Aux Plaines and partly through a narrow, crooked channel into the South Branch, and only in very wet seasons was there sufficient water to float an empty boat. The mud was very deep, and along the edge of the lake grew tall grass and wild rice, often reaching above a man's head, and so strong and dense it was almost impossible to walk through them.

Our empty boats were pulled up the channel and in many places, where there was no water and a hard clay bottom, they were placed on short rollers and in this way moved along until the lake was reached, where we found mud thick and deep, but only at rare intervals was there water. Forked tree branches were tied upon the ends of the boat poles, and these afforded a bearing on the tussocks of grass and roots which enabled the men in the boat to push to some purpose. Four men only remained in a boat and pushed with the poles, while six or eight, others waded in the mud alongside and by united efforts constantly jerking it along, so that from early dawn to dark we succeeded only in passing a part of our boats through to the AuxPlaines outlet, where we found the first hard ground. While a part of our crew were thus employed, others busied themselves in transporting our goods on their backs to the river; it was a laborious day for all.

Those who waded through the mud frequently sank to their waist, and at times were forced to cling to the side of the boat to prevent going over their heads; after reaching the end and camping for the night came the task of ridding themselves from the blood suckers.

The lake was full of these abominal black plagues, and they stuck so tight to the skin that they broke in pieces if force was used to remove them; experience had taught the use of a decoction of tobacco to remove them, and this was resorted to with good success.

Having rid ourselves of the blood suckers, we were assailed by myriads of mosquitoes, that rendered sleep hopeless, though we sought the softest spots on the ground for our beds.

Those who had waded in the lake suffered great agony, their limbs becoming swollen and inflamed, and their sufferings were not ended for two or three days.

It took us three consecutive days of such toil to pass all out boats through this miserable lake; when we finally camped on the banks of the river, our goods had all crossed the portage and we were once more ready to proceed.

Our boats being again loaded, we resumed our voyage down the Desplaines until we reached Isle La Cache, where low water compelled us to again unload our goods in order to pass out boats over the shoal that here presented itself and again we camped after a hard days labor.

Isle La Cache took its name from a circumstance in the life of Mr. Sara, a trader who, when on his way with loaded canoes from Montreal to St. Louis, with goods for the Indian trade, on the Ohio River, camped at this point. A band of Indians demanded of him some of his goods as a tribute for the privilege of passing down the river; this was refused. The Indians then returned to their village, a short distance below, held a council, and determined to stop his canoes as he passed their village, and take by force what he had refused to give. Some of them, however, opposed this robbery and one of the band

reported the act of the council to Mr. Sara.

The night was dark and misty, and Mr. Sara determined to pass if possible by strategy, but to fight rather than to accede to their demands? Fearing he might be overcome by numbers and thus lose his goods and in order to lighten his canoes, so that he could pass rapidly over the shoal places in the river, he ordered the most valuable portion of his goods removed to a grove about a mile distance on the prairie, and there hid them in holes dug in the ground (caches) removing the surplus earth to a distance, and carefully smoothing over the spot, so that no trace of the hiding place could be deen; he then armed his men with guns, tomahawks and knives, and at daybreak started on his way down the river.

Stopping at the village, he stationed his men so as to guard the canoes, and then called on the Indians for a talk which was granted; he told them that he should defend his goods; that the Great Father, the French King had given him permission to go to the Ohio River, and showed them a parchment ornamented with numerous ribbons and large red seals; he said to them 'here is my evidence, the King has made this writing and it tells you that I must not be stopped or disturbed in passing through the nations of his red children; if any harm shall

come to me he will revenge it by sending an army to destroy them and take possession of their country.'

This speech and demonstration had the desired effect, and the Indians were glad to excuse themselves; they however said that they were poor and needed clothing and tobacco; that they had no powder and but few guns and were preparing to send a delegation to St. Louis to see the Great Father's Captain to state their condition and make known their wants.

Mr. Sara replied that he was authorized to give them a present from their Great Father, and that he should have done so but for their demand and threat, but as they had repented, he would now give it to them; whereupon he handed them a small bale which he had previously prepared for that purpose, and ornamented with ribbons and sealing wax. The bale contained a few pieces of calico, powder and shot, tobacco and flints and steels for striking fire, which delighted them exceedingly.

Our progress from this point was very slow indeed, and most of the distance to the Illinois river our goods were carried on our backs, while our lightened boats were pulled over the shallow places, often being compelled to place poles under them, and on these drag them over the rocks and shoals. In this manner almost three weeks were occupied in reaching the mouth of Fox River and two days more brought us to the foot of Starved Rock.

After leaving Starved Rock we met with no further detentions from scarcity of water. We passed on our way a number of Indian villages and stopped a few hours at each, not for the purpose of trading, but only to barter tobacco and powder, for meat and Indian corn."

(Omitting to page 59, which passage describes the re-

turn trip up the river and is as follows:)

"The first night we halted at our old camp ground at the foot of Starved Rock. From this point until we reached Cache Island, our progress was very slow, averaging but from six to ten miles per day. The river was high, the current swift, and the rapids strong and as the boats were heavily laden and a cold storm prevailed, we were glad to camp early and afford the men a muchneeded rest. Early the morning following we left Cache

Island and as the wind was strong from the southwest, we hoisted our square sails for the first time, and rapidly passed up the DesPlaines river, through Mud Lake to South Branch, regardless of the course of the channel, and soon reached Chicago.

We camped on the north side of the river, a small distance above Fort Dearborn, where we remained six or eight days, repairing our boats and putting them in condition for the more serious journey of coasting Lake

Michigan."

(Prof. Alvord continuing): In Volume 3 of the Michigan Pioneer and Historical Collections, on page 125, is an article entitled "Journel of Gurdon S. Hubbard, in 1818. Read before the State Pioneer Society

February 4, 1880."

This was read by Gurdon S. Hubbard himself, and refers

to the use of this water route by Mr. Hubbard.

The passage referred to is as follows:

"I was born at Windsor, Vermont, August 22, 1802. I first saw the Island of Mackinac on the 4th day of July, 1818, then the headquarters of the American Fur Company, under the management of Ramsay Crooks and Robert Stuart.

In March, 1818, I was engaged at Montreal as a Clerk to the American Fur Company for the term of five years on a salary of \$120.00 per annum. We left Lachine on the 13th of May, in twelve Canadian Batteaux, and ascended the St. Lawrence river to Lake Ontario, sailed along its cost to Toronto, at that time called York, then we made a portage of eighteen miles to Lake Simcoe, coasting it to its southern part, then making another portage into Nottawassaga river. Our boats and effects were drawn to Lake Simcoe on wheels over what was called Young street; it was a fair road."

"We descended Nottawassaga river to Georgian Bay, coasting thence to Mackinac. This island was then in its gayest season. All the traders attached to the American Fur Company were assembled there, having brought in their furs, and were preparing to receive their outlits to depart again to their several trading-posts.

The resident population of this island was about 500, principally Canadian, French and half-breeds; their occupation was fishing and trading with the Indians; with

few exceptions they were poor and improvident. There was a garrison composed of about three companies.

After spending two months on the island I was detailed to the Illinois brigade of traders, under the command of Antoine des Champs, a highly educated gentleman who had been more than forty years an Indian trader on the

Mississippi, Illinois, and Ohio rivers.

Our brigade of traders left Mackinaw in September, coasting the eastern shore of Lake Michigan to Chicago: there we found Fort Dearborn garrisoned by United States troops. John Kinzie and A. Ouilmett were the only white inhabitants at that period in Chicago and northern Illinois. Here, three miles up the south branch, our boats were unloaded, our merchandise was carried to the Desplaines river on the mens' backs and the empty boats were hauled through a ditch that was almost dry. to Mud Lake, half way, then through a like ditch into the DesPlaines (in high water this is good navigation), there reloading, we descended the DesPlaines river, having to partially unload our boats and carry the goods on our backs over shallow places and passing the boats over by means of rollers under them until reaching the Illinois river, where, at different points, our trading posts were located sixty or seventy miles apart. In the spring following we returned by the same route; the rivers being full, we had no portage to make, passing the ditches and Mud Lake under full head."

(Prof. Alvord continuing):

Mr. Hubbard died in 1886 at the age of eighty-four.

WARDEN'S HISTORY OF UNITED STATES, 1819.

This book which is now shown me is entitled "A Statistical, Political and Historical Account of the United States of North America; From the Period of their first Colonization to the Present Day. By D. B. Warden, Late Consul for the United

States at Paris, etc. Volume 1, Edinburg 1819."

Mr. Warden was Consul at Paris for forty years. He was born in Ireland and died at Paris in 1845. He was distinguished for his scientific attainments and varied learning. He was appointed as secretary of the legation to General Armstrong, Minister of France. Later he was consul. He published an account of the United States in three volumes in 1819.

I find in Volume 1, page 120, a reference to the river route by way of the Chicago Desplaines, as follows (page 120, para-

graph 17):

"The Illinois River, formerly the Theakiki is formed by the union of three considerable streams, the desPlanes (Plein), De Page and the Kankakee. The first, which rises in the low lands, bordering upon the west side of Lake Michigan runs a southwesterly course. The DePage takes its rise a few miles west of the former and has a nearly The Kankakee rises in a flat marsh parallel course. country, near the St. Joseph of the lake, and takes a meandering westerly course, passing the southern extremity of Lake Michigan, at the distance of twenty or thirty miles. After receiving the waters of this river, the Mississippi meanders through a broad valley, from six to twelve or fourteen miles in width, the sides of which rise in bluffs from the height of forty to a hundred feet. To a considerable distance from its mouth, the width of the The current runs Illinois is between 300 and 400 yards. at the rate of two miles and a half an hour, and affords an uninterrupted navigation of 230 miles for large boats, and for small ones to the distance of 460 miles, where it approaches Lake Michigan. The rapids at the mouth of Vermillion river are only perceivable when the water is low; and between it and the Chicago river. Of this water the largest portage does not exceed four miles and after heavy rains boats pass from one to the other across the isthmus, which is about eight miles in breadth; and, being low and level, a canal communication might be opened at a small expense, which, with the exception of nineteen miles of land carriage, would extend the inland naviga-tion from New York to New Orleans."

(Prof. Alvord continuing):
Having in mind the context, the 19 miles of land carriage
refers to the land carriage around Niagara Falls.

TRIP OF EBENEZER CHILDS, 1821.

The Volume now shown me is volume 4 of the Wisconsin Historical Society Collections. On page 153 begins an article entitled "Recollections of Wisconsin since 1820. By Col. Ebenezer Childs, of LaCrosse."

Ebenezer Childs was born in Massachusetts in 1797, and left that state in 1816. He went to northwest New York where

he remained for three years, and then settled in Cleveland, Ohio. He became a fur trader among the Indians. In 1821 he made a trip to St. Louis and back again. In 1827 he made a trip with cattle to Chicago. He was in 1841 with a party that was surveying the Michigan-Wisconsin line. He was appointed one of the exploring agents of the Indians in 1848. The latter part of his life was passed in Wisconsin.

I find on page 162 a reference to the use of river route in

question by Colonel Childs.

Whereupon the said passage on page 162 was read into the record, as follows:

(Recollections of Wisconsin since 1820, by Col, Ebenezer

Childs, of LaCrosse.)

"In 1821, I made a trip to St. Louis, in a bark canoe up the Fox river, across the portage, and down the Wisconsin to Prairie due Chien, and thence down the Mississippi. I was sixteen days on my journey, and saw but seven white men in the whole distance outside the forts. I met one keel-boat on the Mississippi bound up for Fort Armstrong at Rock Island. There was a small garrison opposite the mouth of the DesMoines River. There were but few Americans and few Spaniards at St. Louis; the inhabitants were mostly French. There was but one brick building in the place, and no buildings were located on Front street, or where the levee now is. I encamped on the sand beach, near where the old market is located. I remanied two weeks, did my business, when I was advised to return by way of the Illinois River.

I started by that route, and the next day was taken down with the ague and fever, and the day following one of my men was also taken with the same complaint, which left me with one Indian and one Frenchman to paddle my canoe. I did not provide a sufficiently large stock of provisions when I left St. Louis, presuming that I could get plenty on the Illinois. But all I was able to obtain was one ham, full of maggots and one peck of Indian meal. I saw but one house from the mouth of the Illinois to Fort Clark, where Peoria now is; at which latter place one French trader resided. When we reached there, I was completely exhausted and remained a few days to recruit a little, when we left to prosecute our journey. We continued up the Illinois to the junction of the Kankakee and Eau Plaines, and thence up the Eau Plaines to where I supposed we had to make a portage to Chicago

River; but I could not see any signs of the portage. There had been heavy rains for several days, which had so raised the streams that they overflowed their banks. I concluded that I had gone far enough for the portage. So I left Eau Plains and took a northeast direction. After traveling a few miles, I found the current of the Chicago River. The whole country was inundated; I found not less than two feet of water all the way across the portage. That night I arrived at Chicago, pitched my tent on the bank of the lake, and went to the fort for provisions."

A GAZETTEER OF ILLINOIS AND MISSOURI BY BECK.

(Prof. Alvord continuing):

The book which is now shown me is entitled "A Gazetteer of the States of Illinois and Missouri, containing a general view of each State—A general view of their counties—and a particular description of their towns, villages, Rivers, etc., With a Map and other Engravings. By Lewis C. Beck, A. M., Member of the New York Historical Society, and of the New York Lyceum of Natural History. Albany, 1823."

Mr. Beck was an American physician, chemist, and mineralogist; was born in Schenectady and graduated at Union. He was a professor of chemistry at Rutger's, and later in the Albany Medical College. He was an author of books on chemistry and botany, and a report on mineralogy of New York based on his own researches when a member of the New York Geological Survey of 1835 to 1841, and published as Volume 1 of the Natural History of the State of New York in 1842. Mr. Beck's Gazetteer has a very good standing among historians and has been used again and again by historians of Illinois and all the historians of the northwest as the source of material for the history of these states, and particularly for its account of the state in the year in which it was published. In his preface Mr. Beck says:

"Under the impression that a more detailed description of these states than had hitherto been published, would be useful, and perhaps interesting I commenced, shortly after my removal to Missouri in 1819, the collection of materials for the present work. I travelled over a considerable portion of these states, and became acquainted with a number of intelligent gentlemen, residing in different parts of them, who afforded me much assistance in the prosecution of my design. The different state officers, also were so obliging as to allow me

the privilege of perusing many valuable documents in their offices, and making such extracts from them as I desired. By these means I acquired the greater part of the information which is contained in the following pages. In the meantime, my visit to New York gave me an opportunity of consulting many works which I was elsewhere unable to obtain. In the very valuable library of the Historical Society, to which I had access, I found, with few exceptions all the earlier, as well as modern authors who treated of that part of Louisiana and the western country, now the states of Illinois and Missouri. Although these works for the most part consisted of the narrations of travellers of general descriptions, they afforded me the means of comparing my own observations and of adding their descriptions of such places as I had either neglected, or had been unable to visit. From the works of Marquette, Hennepin, Tonti, and Charlevoix, I obtained many interesting facts concerning the history of these states, which I have presented in a condensed form. From the more recent works of Stoddard, Brechenridge, the travels of Lewis and Clark, Pike and Bradbury, I have also derived much assistance. In treating of the lead mines and minerals of Missouri, I have constantly referred to the 'View of the Lead Mines of Missouri,' published by Mr. Schoolcraft in 1820."

I find in this volume a reference to the river route to the Mississippi by way of the Chicago and DesPlaines on page 19.

It reads:

"A mere glance at the map of Illinois will be sufficient to convince a person of the least observation, that the union of Lake Michigan with the Illinois river, by means of a canal, is not only practicable, but of easy accomplishment. The position, however, does not rest upon so slight a basis; but in its support, can be adduced the concurrent testimony of all who have explored and examined the country. The fact of an easy, and during some seasons an uninterrupted communication between Lake Michigan and the head waters of the Illinois, was observed by the French at the first discovery of the country; and on this account, they immediately erected trading establishments on different parts of the route. This trade was for a long time enjoyed exclusively by the French, and it contributed in no small degree to the importance of the Canadas. But, as is well known, this has since passed into other hands, and those who discovered the country were for a long time the lords of the soil, are not the mere 'hewers of wood and drawers of water.' Alas, who can account of the strange vicissitudes of fortune? Perhaps, in a few more years, those republican institutions, which are now our pride and boast, may be demolised and the eagle of liberty, now soaring proudly on our air, be driven from our shores to

distant and more congenial claims.

The information of traders and voyagers was such as left no doubt of the existence of a natural canal between Lake Michigan and the Illinois, at some seasons of the year. But as the country had never been carefully examined by men of science and observation, it was difficult to ascertain what were the facilities of forming an artificial communication. All talked of the project as practicable, but none knew the manner in which it was to be accomplished. That the lakes, should be united with the Hudson and Mississippi rivers, was a project none were willing to scrutinize lest its beauty might be destroyed. But thanks to the genius and enterprise of our citizens, theories and dreams have passed away, and have been succeeded by experiment and practice.

A few years since the country south and west of Lake Michigan, was explored by Messrs. Philips and Graham. In a very interesting report which they made to the secretary of war, four different methods of forming a communication between Lake Michigan and the Illinois were

proposed, viz:

First: By uniting a branch of Chicago river, which empties into Lake Michigan, and a branch of the Desplaines, which runs a southeast course and approaches within ten or eleven miles of the lakes, and then turning to the southwest, blends its waters with the Theakiki. These streams approximate within three miles of each other, and when swelled by heavy falls of rain, actually united, so that boats of 8 or 10 tons burthen pass and repass from the lakes to the Mississippi through this natural route.

I shall examine each of these plans somewhat in detail; and first the junction of the Chicago River with the

Des Plaines.

What is called Chicago river or creek, is merely an arm of the lake, extending in a southwesterly direction three or four miles, and fed by one or two small streams coming from the north. Hence it is on a level with the lake, but at some seasons has a gentle current, owing to the rains and freshets. On this stream, about 4 or 5 miles from the lake, is a trading establishment, and here the portage commences which, except, in very dry seasons, is seldom more than 3 miles. From this portage to the Des Plaines, a distance of 4 or 5 miles, is a swamp which is generally filled with water, and is navigable. The whole distance from the Des Plaines to the lake is about 12 miles. The height of the Des Plaines, at the point where the swamp unites with it, is calculated at from 8 to 12 feet. It approached so near the level, that the view from the swamp to the lake is almost uninterrupted. This is further proved by the very fact that at some seasons there is a communication between the Chicago and the Desplaines, which could not be the case if there was any

high land intermediate.

The Des Plaines, for 14 to 16 miles below its junction with the swamp above mentioned, has scarcely any fall, and may be said to be on a level. Below this the rapids commence, and continue for a considerable distance. A short distance below the commencement of the rapids, the lake and Desplaines are supposed to be on a level. To this place, therefore, the canal would only require an average excavation of 6 or 8 feet. It is the opinion of some who have attended to this subject, that the canal should be fed from the Desplaines; but the objections to rivers for supplies of water, apply with double force in this section of country. It is well known that in the spring, all these streams are so filled with water as to overflow their banks for a considerable distance; during this season no canal would be safe, but must unquestionable to be swept away. Again, in the autumn they are on the opposite extreme; creeks, ponds and rivers are completely drained of their water, to supply that immense and greedy conductor the Mississippi. It is not unfrequently the case, that savages and travellers are compelled to carry water with them in bladders, and that they cross the beds of large streams without finding sufficient to quench their thirst. But there is another objection to using rivers as feeders, which, though not so imminent, becomes eventually of serious moment. When the country shall be cultivated, streams swollen by showers will bring down, mixed with their waters, a proportion of mud that, in the stillness of level canal, will subside and chock it

up. There are also other objections, which are that those who construct the canal may not be acquainted with the true character of the streams; and that by the progress of industry, the large springs, and swamps which are the principal supply of those streams will be dried up."

KEATING'S ACCOUNT OF LONG'S EXPEDITION, 1823.

(Prof. Alvord continuing):

The book which is now shown me is entitled "Narrative of an Expedition to the source of St. Peter's River, Lake Winnepeek, Lake of the Woods, etc., Performed in the year 1823 by Order of the Hon. J. C. Calhoun, Secretary of War, under the Command of Stephen H. Long, U. S. T. E. Compiled from the notes of Major Long, Messrs. Say, Keating & Calhoun. By William H. Keating, A. M., etc. Professor of Mineralogy and Chemistry, as applied to the Arts, in the University of Pennsylvania, Geologist and Histriographer to the Expedition. In two Volumes. Vol. 1. London, 1825."

In his preface on page VII he says:

"The principal object which the compiler had in view, was to unite the documents confided to him, so as to present a faithful description of the country over which the party travelled, and of the few adventures which interrupted the monotony of a journey through a wilderness.

It may be well to state, that the Historical part of the narrative, together with the topographical and much of the descriptive matter has been drawn from Major Long's notes. Mr. Calhoun's manuscripts, besides contributing to the same departments, and yielding the astronomical observations, have been very valuable in furnishing the greater part of the reference to older writers. The comparisons between the observations made by our party and the assertions of former travellers, are almost entirely due to that gentleman. From Mr. Say's notes, all that relates to the zoology and botany of the country traversed has been obtained, as well as much of the matter relating to the Indians. This last department has been completed from the compiler's own notes, which have likewise furnished the geological observations. Besides which, the journals kept by each of the gentlemen have frequently completed the observations made by some other member of the party. It has been deemed unnecessary to state, in all cases, by whom the observations were made or recorded. This had, however, been done whenever the facts appeared sufficiently interesting to require that the names of the observers should be annexed to them.

As Major Long's report to the War Department presents a concise summary of the general features of the country visited by the party, it has been thought advisable to introduce in as a conclusion to the narrative. Having been ordered to the Ohio to make an experiment to improve its navigation, according to the provisions of a late act of congress, Major Long was absent from Philadelphia during the preparation of that part of the manuscript which follows the three first chapters of the first volume. This may account for some of the inaccuracies which the work will be found to contain; it is hoped that by his presence they would have been avoided." * * * On page VIII:

"In conclusion, the compiler has much pleasure in acknowledging the great obligations under which he lies to George Ord, Esq., one of the Vice-Presidents of the Academy of Natural Sciences, and one of the Secretaries of the American Philosopohical Society, for his assistance in the preparation of this work. Mr. Ord's perusal of the greater part of the manuscript, previous to its being put to press, has preserved it from many of the inaccuracies

which it would otherwise have contained."

(Prof. Alvord continuing):

I find a reference to the Chicago-Desplaines route on page

167 as follows:

"The south fork of Chicago river takes its rise, about six miles from the fort, in a swamp which communicates also with the DesPlaines, one of the head branches of the Illinois. Having been informed that this route was frequently travelled by traders, and that it had been used by one of the officers of the garrison, who returned with provisions from St. Louis a few days before our arrival at the fort, we determined to ascend the Chicago river in order to observe this interesting division of waters. We accordingly left the fort on the 7th of June, in a boat, which, after having ascended the river about four miles, we exchanged for a narrow pirroggue that drew less water; the stream we were ascending was very narrow, rapid and crooked, presenting a great fall, it continued so for about three miles, when we reached a sort of swamp designated by the Canadian voyages under the name of le petit lac. Our course through this swamp,

which extended for three miles, was very much impeded by the high grass, weeds, etc. through which our pirogue passed with difficulty. Observing that out progress through the fen was very slow, and the day being considerably advanced, we landed on the north bank, and continued our course along the edge of the swamp for about three miles, until we reached the place where the old portage road meets the current, which was here very distinet towards the south. We were delighted at beholding for the first time, a feature so interesting in itself, but which we had afterwards an opportunity of observing frequently on the route, viz: the division of waters starting from the same source, and running in two different directions, so as to become the feeder of streams that discharge themselves into the ocean at immense distances apart. Although at the time we visited it, there was scarcely water enough to permit our pirogue to pass, we could not doubt, that in the spring of the year the route must be a very eligible one. Lieut. Hopson who accompanied us to the DesPlaines told us that he had travelled it with ease, in a boat loaded with lead and flour. The distance from the fort to the intersection of the Portage road and Desplaines is supposed to be about twelve or thirteen miles; the elevation of the feeding lake above Chicago river was estimated at five or six feet; and, it is probable that the descent to the Desplaines is less considerable. The portage road is about eleven miles lone; the usual distance travelled by land seldom however exceeds from four to nine miles; in very dry seasons it has been said to amount to thirty miles, as the portage then extends to Mount Juliet, near the confluence of the Kankakee."

TRIP OF JOHN H. FONDA, 1825.

(Prof. Alvord continuing):

Referring now to volume 5 of the Wisconsin Historical Society Reports, and to the portion thereof that commences on page 205, entitled "Early Reminescences of Wisconsin, by John M. Fonda," I find in small type introducing the article, the following:

"The following series of historical papers were written by the editor of the Prairie du Chien Courier, as dictated by the aged pioneer, whose name they bear, and appeared in that paper, commencing with the number of Feb. 15th, 1858, and extending into May following. 'We would advise all,' says the editor, 'to read the Early Reminiscences, as they are extremely interesting, and contain many historical facts, that will pay for the time spent in perusal. The subject of these sketches has been in the West for over forty years, and thirty years a resident of Prairie du Chien. He has lived to see most of the early pioneers carried to the grave. His life has been an eventful one, abounding in incidents of travel, camp and field, that will prove interesting to our readers. They are as correct and truthful as memory can make them.'

Mr. Fonda was born in Watervliet, Albany County, N. Y., and is still residing in Prairie du Chien. We have the high authority of the venerable Rev. Alfred Brunson, of Prairie du Chien, for assuring the reader that 'Mr. Fonda's narrative is as reliable as anything of the kind

given from memory."

The "L. C. D." is Lyman C. Draper, Secretary of the Wisconsin Historical Society for many years. I find also a reference to the Chicago Des-Plaines river route on page 216 as

follows:

"While engaged in securing the choicest portions of the venison, our Indian guide told us it was but a short distance to a larger body of water, on the shores of which lived the chief of his tribe, whose name was Muck-ke-tay-This piece of intelligence made us think we were near the large lake—Lake Michigan; but we were disappointed, for late in the afternoon, we entered the foot of Lake Peoria, and were met at landing by a number of Indians, from whom we learned that it was more than two hundred miles to the nearest trading post on the lake, which was Chicago. We had to remain with this tribe several days, before our guide would leave the encampment; and during which time I saw several Indians of other tribes, one of whom was Black Hawk, whom I afterward found out, as then trying to get these Indians to join the Winnebagoes against the whites in the North-West. At length the councils were concluded, and our guide signified his willingness to proceed. Under his direction we paddled along until we came to the Desplaines river, from which we passed into a large slough or lake, that must have led us into a branch of the Chicago river, for we followed a stream that brought us opposite Fort Dearborn.

At this period, Chicago was merely an Indian agency; it contained about fourteen houses, and not more than 75 or 100 inhabitants at the most. An agent of the American Fur Company named Gurdon S. Hubbard, then occupied the Fort. The staple business seemed to be carried on by Indians, and run-away soldiers, who hunted ducks and musk rats in the marshes. There was a great deal of low land, and mostly destitute of timber. The principal inhabitants were the agent, Mr. Hubbard, a Frenchman by the name of Ouilmette, and John B. Beaubien." There is a foot note reading as follows:

"Antoine Ouilmette, whose wife was a Pottawattamie woman, is mentioned in the treaty at Prarie du Chien, in 1839, with the Chippewas, Ottowas, etc; and at the treaty of Chicago, September 1863, provision is made for his children. It would appear that he died during the interim

between the two treaties. L. C. D."

DROWN'S RECORD AND HISTORICAL VIEW OF PEORIA.

(Prof. Alvord continuing):

The book now shown me is entitled "Drown's Record and Historical View of Peoria, from the Discovery by the French Jesuit Missionaries in the Seventeenth Century to the Present time. Also an Almanac for 1851. By F. DeWitt Drown,

Peoria, 1850."

This is one of those volumes of local description written by a man that was interested in antiquarianism, who made a compilation, the basis of which was descriptions and histories written by others, and also the reminiscences of the men among whom he lived. Historians would use this as source material accepting those statements in it which would be based upon information which he might well have obtained.

This book was used by Judge McCulloch. I find it in a reference to the Des Plaines-Chicago river route on page 83.

Said extract is as follows:

"Another of our old pioneers and citizens, who is still with us, Mr. John Hamlin, of Mass. He came here in the spring of 1821 from Springfield, in company with Judge Lockwood, Judge Lathem (who afterwards became a citizen and proprietor of city lots, and died here in 1826, and whom I shall have occasion hereafter to notice.) Iles, Gen. J. Adams, and a Mr. Winchester, Maj. Graham, Indian agent, of St. Louis, came here about that time with a keel boat and proceeded up to LaSalle prairie (Rome)

where he paid off the Indians their annuity. Some of them returned and settled here subsequently, and be-

came useful citizens in building up our city.

In 1832 an Indian Agency was opened and established here by the Government, of which Judge Latham was appointed Agent, in place of Maj. Graham, of St. Louis, where it had heretofore been kept. John Hamlin, Esq., was a clerk, in and kept a branch of the American Fur Company's store in this place, in one of the buildings in the center of the view between Water st. and the Lakethe building from the right, just below the Inn sign-post. In this store were kept Indian commodities chiefly. A portion, however, was adapted to the wants of the citizens, who, at this time, were few. Mr. Hamlin while thus engaged in this store, exported the first produce to Chicago in 1825, in keel boats as far as the mouth of the Kankakee river, and from there in Durham boats to Chicago (having built a storehouse at the former place to store in from the keel boats to be taken by the Durham boats up the Aux Plain river.

The principal articles exported were pork, beans and other provisions for the use of the Fur Company. There were but a very few families till within a few years of this time, in the present bounds of the city, till about

1832."

(Prof. Alvord continuing):

If the historian were going to use this material he would regard Drown's Peoria as belonging to the primary source of materials, containing information by a man who would have been able to have perceived things himself and would have been able to have learned from others the facts. would not use Drown's for the history of the 18th century. That he has taken, of course, from other narratives, and, he is not a trained historian capable of estimating historical evidence, but that information contained in the book, based upon his own observations, or based upon the observations of others, would be taken by historians as source material, and so used as they use other source material. I would regard the facts stated as of weight to be taken into consideration in connection with facts stated by others of a similar nature. All good histories are based upon the use of such material, and the fact that the historians states ultimately is the one which he deducts from a number of statements of that kind, from that class of material, and that is the way we have to write history.

I stated that David McCulloch had given some consideration to the book to which I have just referred. Mr. McCulloch

The book now shown me is entitled "Early Days of Peoria and Chicago, by David McCulloch," which I have already characterized. And he refers in this book to the Hamlin incident covered by Mr. Drown's book, as follows:

"The difficulties and dangers accompanying trade and travel in those early days may be illustrated by a very few incidents. Farmers were accustomed to haul their grain, pork and other products from Peoria to Chicago by wagon, and there to purchase lumber for their houses, salt for their pork and supplies for their families. Those doing business on the river transported their pork, furs, peltries and other products by Mackinaw boats and canoes, making the portage between the Desplaines and Chicago rivers by land. While in the fur business at Peoria, John Hamlin conceived the bold idea of shipping his pork by keel-boat a portion of the distance, the remainder by Mackinaw boat to Chicago. Packing his pork in a keel-boat and his fur in a Mackinaw boat, he proceeded to the mouth of the Desplaines, where he unloaded his keel-boat and built a depot for his pork, leaving the same in charge of some boatmen, while he went through with his Mackinaw boat by way of Summit and Mud Lake to the Chicago river and arrived safely at Chicago with his furs. He then returned and brought his pork through in the same way, thus establishing a continuous waterway for trade between the Great Lakes and the Mississippi Valley."

REPORT OF SELECT COMMITTEE OF CONGRESS FEBRUARY 1, 1825.

Whereupon the attorneys for the government offered in evidence the "Report of the Select Committee to which was referred on the 3rd ultimo, a memorial of the General Assembly of Illinois, upon the subject of a Canal Communication between the Illinois River and Lake Michigan accompanied with a bill to aid the State of Illinois in the accomplishment of the same," which is found in the Reports of Committees, 18th Congress, Second Session, printed under the authority of Congress. Report No. 53, as follows:

"February 1, 1825. Read, and, with the Bill, committed to a Committee of the whole House.

The Select Committee to which was referred the memorial of the General Assembly of the State of Illinois, praying for aid from the United States in opening a canal to connect the water of the Illinois river and Lake Michigan,

respectfully submit the following report.

The memorial represents that the committee find to be true, that in 1820, a law was passed by Congress, authorizing the said state to open a canal through the public lands to effect this communication, which is required to be done within a given period. It further represents that the General Assembly has already proceeded so far as to appoint commissioners to explore the route and prepare the necessary surveys and estimates preparatory to its execution. It further represents that the state is unable out of its own resources, to defray the expenses of the undertaking; and, therefore, prays Congress to make to the state a grant of public land, or such other assistance, as may be thought most proper to enable

the state to proceed with the work.

In examining this subject, the attention of the committee has been drawn to several points which seem naturally to bear upon it; the first, as to the practicability of making the proposed connection of those waters. On this branch of their inquiries the committee can see no room to doubt. Although the report of the state commissioners and engineers had not been made to the General Assembly at the time of adopting the memorial that has been referred to the committee, the legislature of that state entertained no doubt on that point. Such, indeed, is the concurrence of scientific observation and actual experience in relation to that fact, that in order to establish it the report was not necessary. The experience to which the committee refers, is that of many years, and which is matter of historical notoriety. It is that of repeated passages having been made, by uninterrupted navigation from the river into the lake. With respect to the scientific observations that have been made, the committee refer to the report of Major Long to the Secretary of War in 1817, and which was printed by order of Congress. In this report (see vol, 2, No. 17 of the reports of the first session of the 16th Congress) it is stated that 'the Illinois river is about 300 miles in length, and is of variable width, from seventy yards to one mile. It has a very moderate current, and a depth

of water sufficient to render it navigable, at all times, for boats of considerable burden, about 230 miles from its mouth.' In speaking of the proposed canal, Major Long observes, 'a canal uniting the waters of the Illinois river with those of Lake Michigan, may be considered the first in importance of any in this quarter of the country, and at the same time the construction of it would be attended with very little expense compared with the magnitude of the object. By a reference to the document before referred to it will also be seen that another report was made on the same subject by Richard Graham, Esq., and the late Chief Justice Philips, of the State of Illinois. Without quoting particularly from their intelligent report, it will be sufficient to observe that they coincide substantially with Major Long. They present, however, the further fact that is perfectly practicable to employ the water of the lake, as to furnish a full supply of water for the canal."

REPORT OF THE COMMITTEE ON ROADS AND CANALS, MARCH 30, 1826.

Counsel for the government also offered in evidence the report of the Committee on Roads and Canals, "to which was referred a memorial of the General Assembly of the State of Illinois, concerning a canal to connect Lake Michigan and the Illinois river, the same having been made March 30, 1826," which is found in the report of Committees, first session 19th Congress, published under authority of Congress and stated that the full committee adopted the report of the Select Committee which has just been offered in evidence and that the final report of the entire committee was the same as the Select Committee, and it is not recopied in the record because it is a mere production of the preceding extract.

EXTRACTS FROM THE NAVIGATOR.

(Prof. Alvord continuing):

The book which is now shown me is entitled "The Navigator, Containing Directions For Navigating The Ohio and Mississippi Rivers; With An Ample Account of These Much Admired Waters, From The Head Of The Former To The Mouth Of The Latter; And A concise Description Of Their Towns, Villages, Harbors, Settlements, &c. With Maps Of The

Ohio And Mississippi, To Which Is Added An Appendix Containing An Account Of Louisiana, And Of The Missouri And Columbia Rivers, As Discovered By The Voyage Under Capts. Lewis And Clark." Published at Pittsburg, 1824.

In the advertisement at the beginning we find the follow-

ing:

"This edition of the Navigator, being the eleventh since the year 1801 is respectfully presented to the public. It being designedly calculated as an useful and necessary guide to those who navigate or trade on the rivers of which it treats—much pains have been taken to revise, correct and enlarge it throughout. To do this satisfactorily, we have had the assistance of several of the most eminent pilots and navigators, and the use of late manuscript, journals of gentlemen of observation, to whom we present our compliments for their aid and politeness.

This edition is considerably enlarged by a more comprehensive description of the principal towns on and adjacent to the rivers; their commerce and manufacturers; natural curiosities of the country, etc. The directions for navigating the Mississippi river from the mouth of the Illinois to that of the Ohio river, with the description of the district of Mobile, and geographical notice of Florida will be found interesting."

(Prof. Alvord continuing):

This book is regarded by historians as the source of information in regard to the west and the navigation of the rivers in the west and has been used as such by historians. I find in this book a passage at page 113 a reference to the

river route in question as follows:

"Between a branch of the Illinois and the Chicago river, which empties into Lake Michigan there is a portage of two miles; from this portage to the lake is a batteaux navigation of 16 miles. By this happy connection of waters, there is a complete communication from New York to New Orleans, through that northern and extensive route, having only about 28 miles land carriage in the distance of nearly 4000 miles, the greatest stretch of inland navigation perhaps known in the world. This route from New York is by the Hudson river to Albany; thence by land to Schenectedy, 16 miles; thence up the Mohawk river, and through a canal of 4 miles into Wood creek; thence into Lake Ontario, and up that lake and

Niagara; thence ten miles land carriage around said falls to Chippeway, thence up the river into Lake Erie, and through that lake into Lake St. Clair; thence into Lake Huron through Lake Michigan, and into the Chicago river mentioned above; thence down the Illinois and Mississippi rivers. This route comprehends the most extensive channels, and gives a wide scope to trade in general, and may one day be made a very profitable use of to individual citizens, as well as highly advantageous to the trade and commerce of the United States, especially if they get possession of the northern fur trade now carried on by the British."

FLINT'S HISTORY, 1832.

(Prof. Alvord continuing):

The book to which my attention is now directed is entitled "The History and Geography of the Mississippi Valley. To which is appended a Condensed Physical Geography of the Atlantic United States, and the whole American Continent. Second Edition. By Timothy Flint. Author of 'Recollections of the Last Ten Years in the Mississippi Valley.' In two

volumes. Vol. 1. Cincinnati, 1832."

Timothy Flint was a very famous writer, and western pioneer. He was born in Massachusetts in 1780 and died in Salem in 1840. He was a Congregational minister and missionary to the Mississippi Valley after 1815. He left the active practice of ministry and became a teacher at Cincinnati and on the Red River. In 1825, broken in health, he went back to Massachusetts. In 1833 he was editor of the Knickerbocker Western Review, Cincinnati, and lived at Alexandria, Virginia. He published a history and geography of the Mississippi Valley, Indian Wars in the West; Memoir of Daniel Boone; Recollections of last ten years in the Mississippi Valley.

Flint was one of the most widely read writers on the west of his age. His books had a very large sale both in this country and in Europe. He traveled extensively over the west and everybody has given him the reputation of being a keen observer and a man who was careful in making statements of facts. On page 322 of his book occurs the follow-

ing:

"Rivers. It is only necessary to look on the map of this state, to see what astonishing advantages for in-

land navigation nature has given it. On its northern extent it has for a great distance the waters of Lake Michigan, and the boatable streams that empty into it: and by this vast body of waters, a communication is opened with the northern fronts of Indiana and Ohio; with New York and Canada. On the northwest frontier it has Rock River, a long, beautiful and boatable river of the Mississippi. On the whole western front it is washed by the Mississippi; and on its southern by the Ohio. On the east it is bounded by the Wabash. Through its centre, winds, in one direction, the Illinois, connecting the Mississippi with Lake Michigan by the Plein and Kankakee, a river, excepting a short distance of shoals, almost as uniformly boatable as a canal; and in another direction, the beautiful Kaskaskia winds through the state. Besides these, there are great numbers of boatable streams, penetrating the state in every direction. Such is the intersection of this state by these waters. that no settlement in it is far from a point of boatable communication, either with Lake Michigan, the Mississippi, or the Ohio. It may be added that when the state shall have been inhabited as it will be, as no country affords greater facilities for making canals, from the friability of the soil, its levelness, and the proximity of the source of the boatable waters to each other, canals will complete the chain of communications, and transport will be almost as entirely by water in Illinois, as it now is in Holland or China. At present the state is supposed to have 4,000 miles of boatable waters in her limits.

The Illinois, which gives name to the state, may be considered the most important river, whose whole course is in it. It rises in the northeastern parts of the state, not more than 35 miles from the southwestern extremity of lake Michigan and interlocking by a morass with the river Chicago, which empties into that lake. Its two main head branches are Plein and Kankakee. Thirty miles from the junction of these rivers, enters Fox Rixer, from the north. Between this and the Vermillion, enter two or three inconsiderable rivers. The Vermillion is a considerable stream, which enters the Illinois from the south, 260 miles above the Mississippi. Not far below this river, and two hundred and ten miles above the Mississippi commences Peoria lake, which is no more than an enlargement of the river, two miles wide, on an average, and twenty miles in length. Such is the depth

and regularity of the bottom, that it has no perceptible current whatever. It is a beautiful sheet of water, with romantic shores, generally bounded by prairies; and no waters in the world furnish finer sport for the angler. M'Kee's and Red Bud enter not far from this point. Crow-Meadow River almost interlocks, at its course, with the Vermillion of the Wabash. Two or three inconsiderable streams enter the river from the north, not far from the lower extremity of Peoria Lake. Still lower down enters from the south Michilimackinack, a very considerable stream, boatable nearly a hundred miles from the river into the interior. Below this enter Spoon and Crooked Rivers. Still lower down on the same side enters the Sangamon by a mouth 100 yards wide; and is boatable 140 miles. From its position, and the excellence of its land, it is one of the most important rivers of the state. Chariton, Otter, Apple and Macoupin Rivers are all considerable streams, that water fine tracts of

country.

On the north side of the Illinois, the rivers that enter on that shore, have their courses, for the most part, in mountainous bluffs, which often approach near the river. For a great distance above its mouth, the river is almost as straight as a canal; has in summer scarcely a perceptible current, and the waters, though transparent, have a marshy taste to a degree to be almost unpotable. The river is wide and deep; and for the greater part of its width, is filled with aquatic weeds, to such a degree that no person could swim among them. Only a few yards width, in the centre of the stream, is free from them. It enters the Mississippi through a deep forest, by a mouth 400 yards wide. Perhaps no river of the western country has so fine a boatable navigation for such a great distance, or waters a richer and more luxuriant tract of country. On the banks of this river the first French immigrants from Canada fixed themselves; and here was the scenery on which they founded their extravagant paintings of the western country. By a moderate amount of labor and expense, this river might be united with the Chicago of Lake Michigan. Appropriations have already been made by the state for the canal, that is intended to effectuate this purpose. already remarked that at certain seasons of the year, boats of five tons burden already pass through the morass, from one extremity of which the waters are discharged into the Chicago of Lake Michigan; and from the other into the Plein of the Illinois; thus furnishing a natural communication between the two rivers, whose outlets are so wide and opposite from each other. Indeed, by the most obvious appearances, along the Illinois and some of its waters, as the Plein for example, it is manifest, that lake Michigan once discharged at least a part of its surplus waters into the Mississippi. This, too, may explain the obvious appearance in that lake of being now many feet lower than once it was. This fact is palpably marked everywhere along the rocky shores of the lake."

SCHOOLCRAFT'S STATEMENT OF 1832.

(Prof. Alvord continuing):

The next book called to my attention is entitled "Narrative of an Expedition Through the Upper Mississippi to Itasca Lake, the Actual Source of this River: Embracing an Exploratory Trip Through the St. Croix and Burntwood (Or Broule) Rivers; in 1832. Under the direction of Henry R. Schoolcraft."

The book is dedicated to Gen. Hugh Brady of the United

States Army. In the preface occurs the following:

"The Hon. Hugh Brady, of the United States Army."

"The circumstances under which the present expedition was undertaken, are indicated in the following extract from the letters of instruction.

Detroit, Aug. 9, 1830.

Sirs: I have been directed by the War Department to request you to proceed into the Chippewas country, to endeavor to put an end to the hostilities between the Chippewas and the Sioux. The general route must be left to your discretion. Whether it will be necessary for you to go beyond Fond du lac, you can best determine on your arrival there. From the limited means applicable to this object, I am apprehensive that your journey cannot be extended beyond that place. But in that event, it will be necessary to summon some of the principal Mississippi chiefs to meet you, as without concurrence no durable pacification can be effected.

(Signed) "Lew Cass."

August 9, 1830. (Prof. Alvord continuing):

The letter is dated August 9, 1830.

There also appears the following letter dated May 3, 1832:

"Department of War,

Office of Indian Affairs, May 3, 1832.

Sir:

Your letter of Feb. 13th has been received and its general views are approved. The Secretary of War deems it important that you should proceed to the country upon the heads of the Mississippi, and visit as many of the Indians in that, and the intermediate region, as circum-

stances will permit.

Reports have reached the department, from various quarters, that the Indians upon our frontiers are in an unquiet state, and that there is a prospect of extensive hostilities among themselves. It is no less the dictate of humanity, than of policy to repress this feeling and to establish permanent peace among these tribes. It is also important to inspect the condition of the trade in that remote country, and the conduct of the traders. To ascertain whether the regulations and laws are complied with, and to suggest such alterations as may be required. And finally to inquire into the numbers standing, disposition and prospects of the Indians, and to report all the statistical facts you can procure and which will be useful to the government in its operations, or to the community in the investigation of these subjects.

Signed ELBERT HERRING."

(Prof. Alvord continuing):

Elbert Herring was in the Department of War office of In-

dian affairs.

In Schoolcraft's book entitled "Narrative of an Expedition Through the Upper Mississippi," etc., at page 121, occurs the following passage:

"Introductory Memoranda.

The principal points at which the waters of the Mississippi River, communicate, by interlocking rivers and portages, with the lakes, are the following, proceeding from south to north, namely.

1. By the Illinois and Chicago Creek, (with Lake

Michigan).

By the Wisconsin and Fox Rivers, (with Green

Bay). 3. By the Chippewa and Mushkee (or Mauvals Rivers, with Lake Superior.)

4. By the St. Croix and Burntwood (or Brule) Rivers (do).

5. By the Savanne and St. Louis Rivers. (do)

The routes by the Illinois, and by the Wisconsin, were first laid open by French enterprise, and have been used for canoes and flat-bottomed boats in their natural state, and without any practical improvement which as yet, facilitates the communication, about a hundred and sixty years. They are so familiar in our geography have been so much explored, and are so well appreciated, as prominent points for effecting canal and railroad routes, that it is only to be desired that early and efficient measures should be taken for opening them."

EXTRACTS FROM "A WINTER IN THE WEST" BY CHARLES F. HOFFMAN, 1835.

(Prof. Alvord continuing):

The next book called to my attention is entitled "A Winter in the West," by a New Yorker. In two Volumes. Volume 1.

New York, 1835.

The book is written as is well known, by Charles F. Hoffman, who was a son of Judge J. Ogden Hoffman, and was born in New York in 1806. He studied law which he practiced for several years. He was editor, with Charles King, of New York of the American, and begun the Knickerbocker Magazine. Mr. Hoffman's description of the West has been regarded by historians and others as containing facts within his observation, and also knowledge that he has obtained from others. He has a very great reputation as a narrator of his

experiences in the west. In his preface he says:

"Several of these letters have already appeared in the New York American;-the favorable reception they have met with has induced the writer to complete the series and publish them in the present form. In preparing them for publication, he has thought proper to illustrate some of the facts contained in them, by observations derived from other sources or made subsequent to their date. These additions the author has preferred to place in an appendix rather than embody them with the original matter, as he feared that whatever attraction his sketches or scenery and manners might possess would evaporate upon throwing them into a different form and their chief merit as first and faithful impressions would be lost. The eloquent writings of Mr. Flint, the graphic sketches of Judge Hall, and the valuable scientific researches of Mr. Schoolcraft, Professor Keating, and the lamented Sav. have already made the regions described in these pages well known to the public; but there is an ever-salient freshness in the theme of "The Far West."

On page 242 of his book occurs a letter which is dated

Chicago, Illinois, January 10, 1834.

"The town (Chicago) lies upon a deal level along the banks of a narrow forked river, and is spread over a wide extent of surface to the shores of the lake, while vessels of considerable draught of water can, by means of the river unload in the center of the place. I believe I have already mentioned that four-fifths of the population have come in since last spring; the erection of new buildings during the summer has been in the same proportion; and although a place of such mushroom growth can, of course, boast of but little solid improvement in the way of building, yet contracts have been made for the ensuing season which must soon give Chicago much of that metropolitan appearance it is destined so promptly to assume. As a place of business, its situation at the central head of the Mississippi Valley will make it the New Orleans of the north; and its easy and close intercourse with the most flourishing eastern cities will give it the advantage, as its capital increases, of all their improvements in the mode of living.

There is one improvement to be made, however, in this section of the country which will greatly influence the permanent value of property in Chicago. I allude to a canal from the head of Lake Michigan to the head of steam navigation on the Illinois, the route of which has been long since surveyed. The distance to be overcome is something like ninety miles; and when you remember that the head-waters of the Illinois rise within eleven miles of Chicago River, and that a level plain of not more than eight feet elevation above the latter is the only intervening obstacle, you can conceive how easy it would be to drain Lake Michigan into the Mississippi by this route; boats of eighteen tons having actually passed over the intervening prairie at high water, Lake Michigan, which is several feet or more above Lake Erie, would afford such a never failing body of water that it would keep steamboats afloat on the route in the driest season. St. Louis would then be brought comparatively near to New York, while two-thirds of the Mississippi Valley would be supplied by this route immediately from the markets of the latter. This canal is the only remaining link wanting to complete the most stupendous chain of inlaid communication in the world. I had a long conversation this morning on the subject, with Major N., the United States' engineer, who is engaged in superintending the construction of a pier at this place. He was polite enough to sketch the main features of the route with his pencil, in such a manner as to make its feasibility very apparent. The canal would pass for the whole distance through a prairie country, where every production of the field and the garden can be raised with scarcely any toil, and where the most prolific soil in the world requires no other preparation for planting than passing the plough over its bosom. The most effectual mode of making this canal would be to give the lands along its banks to an incorporated company, who should construct the work within a certain time. The matter construct the work within a certain time. is now merely agitated at elections as a political handle."

COMMENT BY PROFESSOR ALVORD UPON THE VALIDITY OF SCHOOL-CRAFT'S STATEMENT.

The statement just referred to as contained in the volume

of Henry R. Schoolcraft as follows:

"The routes by the Illinois, and by the Wisconsin, were first laid open by French enterprise, and have been used for canoes and flat-bottomed boats in their natural state, and without any practical improvement which as yet, facilitates the communication, about a hundred

and sixty years."

coming from a man like Mr. Henry R. Shoolcraft would be regarded by historians as a statement by a man that was well versed in the history of the region, had made a special study of just such conditions, had had opportunities to talk with very many traders, who were accustomed to use the various trading routes, between the Mississippi waters and the great lakes, and therefore it would be given great weight as historical testimony.

WOODRUFF'S HISTORY OF WILL COUNTY.

(Prof. Alvord continuing):

The book which is now shown me is entitled "The History of Will County, Illinois, containing a History of the County, its Cities, Towns, &c., a Directory of its Real Estate

Owners; Portraits of Early Settlers and Prominent men; General and Local Statistics; Map of Will County; History of Illinois, Illustrated; History of the Northwest, Illustrated; Constitution of the United States, Miscellaneous Matters, etc., Chicago, 1878."

I find in the preface the following statement:

"In presenting our History of Will County, we deem a few prefatory words necessary. We have spared neither pains nor expense to fulfill our engagement with our patrons and make the work as complete as possible. We have acted upon the principle that justice to those who have subscribed, be they few or many, requires that the work should be as well done as if it was patronized by every citizen in the country. We do not claim that our work is entirely free from errors; such a result could not be attained by the utmost care and foresight of ordinary mortals. The General History of the County was compiled by Hon. Geo. H. Woodruff of Joliet, and the township histories by our historians, W. H. Perrin and H. H. Hill. Some of the township histories are indeed longer than others, as the townships are older, containing larger cities and towns, and have been the scenes, of more important and interesting events."

(Prof. Alvord continuing): Local historians who have compiled this book and other volumes like it, have had access to material that is not easily accessible to the general historian; and therefore they have used not only this book but books of this general character as source material for information on local conditions. I find in this book on page 607 a passage which refers to the use of the water route between Lake Michigan and the Des-

plaines river as follows:

"The Kankakee being navigable for small steamers to the eastern point, an outlet is thus furnished for the upper portion. Though navigation has been improved by the building of the dams at Wilmington, it has in reality been used for that purpose during wet seasons since the earliest settlements of the adjacent country. As early as 1834, the products of the farm were boated down the Kankakee to Desplaines and up the latter river to Chicago. It is related that during the year named some parties loaded a boat on Sugar Creek, a tributary to the Iroquois, with 300 bushels of oats, 300 bushels of wheat and some hams, with the design of taking them to

Chicago to supply the garrison stations there. The trip down the Kankakee was accomplished without accident or unusual trouble; but after entering the Desplaines. when near Treat's Island, the boat dipped water and so dampened the grain that they were obliged to unload and try to dispose of their produce at that point. At that time, settlers were arriving in that neighborhood quite rapidly, and they had no trouble in disposing of their whole cargo, the oats at 50 and the wheat at 75 cents per bushel. At present small steamers owned by Messrs. Small of Wilmington, and Stephen F. Hanford. Warner's landing, ply regularly between these points and Chicago, carrying to that city corn, oats, rye, and other products, and bringing back lumber, salt, and other heavy articles. The 'Landing,' which is located near the eastern point of the township, is considered the head of navigation during the dry season but when the river is ordinarily full, boats can run much higher."

REPORT OF MAJOR WILSON, U. S. ENGINEER, 1867.

Whereupon counsel for the government introduced into the record from the report of the Secretary of War during the 3rd session of the 40th Congress, 1868-1869, the report of James H. Wilson, Lieutenant Colonel, 35th Infantry, Brevet Major General U. S. A., and William Goodwin, United States Civil Engineer to the Secretary of War. Said extract was as follows (p. 439):

"Report upon the Survey of the Illinois River. United States Engineer Office, Davenport, Iowa, December 17,

1867.

Having been designated by direction of the Secretary of War through engineer orders dated Washington, May 8, 1867, as a Board to conduct surveys and examinations and to prepare plans and estimates for a system of navigation by way of the Illinois river between the Mississippi and Lake Michigan adapted to military, naval and commercial purposes, in accordance with the Act of March 2, 1867, we have the honor to submit the following report."

Omitting to page 439.

"By a careful examination of the report and profiles of this year's survey, with the map herewith submitted, it will be seen that the location of the present canal from

Bridgeport to the valley of the DesPlaines cannot be advantageously or economically changed; that it is the best, cheapest and most direct route which can be found. there having been more than enough work already done in this line to counterbalance the natural but not superior advantages of the slightly lower but more tortuous route by the way of Mud Lake; that the Calumet River and Saganaska creek route, along what is known as the Calumet feeder, would cost a great deal more than either of the others, being longer and ending at a point where there is neither a natural nor artificial harbor, and where it would be impossible to construct one which would answer the purposes of commerce and the national defense; and, finally, that it is not practicable at any cost to use any part of the Kankakee river as a part of the system of navigation in question. For the foregoing reasons, after a careful consideration of all the facts upon which they rest-a full analysis of which will be given hereinafter-we are decidedly of the opinion that in constructing such a system of navigation as the interests of the country require, the government must follow the general line of the Illinois and Michigan canal and the Illinois river. When it is considered that the summit of the Fox and Wisconsin river line is 315 feet, and that of the lake Winnebago and Rock river is 285 feet above the level of Lake Michigan, it will be seen that the line recommended by us is the only feasible route for deepwater communication between the great lakes and the Mississippi river, equally adapted to military, naval and commercial purposes."

Then omitting again to page 432:

"The Desplaines river rises in the State of Wisconsin and runs nearly due south, parallel with the lake shore, and generally nor more than eight or ten miles from it, until it reaches a point about 13 miles in a southwest direction from the mouth of Chicago river. Here is a slight depression a mile or more in width extending across from the DesPlaines to the south branch of Chicago river, through which a part of the waters of the former river, in time of floods, flow into the lake. In this depression is what was once known as Portage Lake (so designated on the old maps of the country), but now better known as Mud Lake, a succession of shallow ponds on the same level connected with each other and with the DesPlaines river,

and extending about six miles toward Chicago river. This was the portage or carrying place between the waters of the lakes and the Mississippi made memorable by the early French voyageurs, and so well known to fur traders. But Portage or Mud Lake has ceased to exist, the shallow ponds having been drained, and the im-

passable swamps rendered valuable land.

There can be no doubt that through this depression there was once an outlet from the lakes to the Mississippi. which was closed by the recession of the waters of the lakes. Even now at the present state of Lake Michigan, its surface is only between eight and nine feet below this summit. The Desplaines river, from the depression described, changes its course and runs in a nearly southwest direction until it forms a junction with the Kankakee. The river itself, except in floods, is very shallow, being often reduced in dry seasons to a mere brook, discharging less than 1,000 cubic feet of water per minute. But the valley averages a mile wide, and is terminated on both sides by well-marked terraces which become higher and higher as they approach the Illinois. Evidence at every step presents itself that the water, when this was the great outlet of the lakes, extended from bluff to bluff."

ILLINOIS IN 1837.

(Prof. Alvord continuing):

The book which is now shown me is entitled "Illinois in 1837"; A sketch descriptive of the Situation, Boundaries, Face of the Country, Prominent Districts, Prairies, Rivers, Minerals, Animals, Agricultural Productions, Public Lands, Plans of Internal Improvement, Manufacturers, etc., of the State of Illionis; Also, Suggestions to Emigrants," and so forth, Philadelphia, 1837. The name of the author is not given. In the preface at page vii, the author writes:

"The bulk of the information hereinafter detailed is quite recent, being derived in part from the lately published and valuable Gazetteer of Illinois, and the Emigrant's Guide, by the Rev. J. M. Peck; also, from Flint's Geography and History of the Western States, Beck's Gazatteer of Illinois and Missouri, Schoolcraft's Travels and works of Darby, Hall, Long, etc. The work contains, likewise, extracts from different correspondents and

from various gazettes printed in the state, some of them only a few weeks before its publication; particularly the Peoria Register and Northwestern Gazetteer, the attention bestowed by the editor of which in distributing recent geographical and local information calculated to be useful to emigrants, renders it undoubtedly the most interesting print of the kind in the state."

(Prof. Alvord continuing):

On page 36 occurs a passage referring to this river route as

follows:

"The DesPlaines river is the northern head branch of the Illinois. It rises in Wisconsin territory, a few miles west of the town of Racine, on Lake Michigan, and flowing through the north part of the state, it joins the Kankakee at the boundary line between LaSalle and Will counties, where they form the Illinois river. The Desplaines in its course of 150 miles runs generally over a bed of limestone. The country along its borders is populating rapidly, notwithstanding the apparent deficiency of timber. About forty-two miles above the mouth of this stream is a swamp connecting it with the Chicago river, through which boats of some burden have often been navigated into Lake Michigan. This route was used by the traders as a medium of communication between the Great Lakes and the Mississippi, from the first discovery of the country by Europeans;-this circumstance first suggested the idea of an artificial connexion by means of a canal at this point," (Prof. Alvord continuing):

Referring to this work of local history and other local histories of this character, the scientifically inclined historian is obliged by the laws of his science to get back to the contemporary narrative as far as it is possible; or if it is impossible to reach the contemporary narrative, to reach these men that knew of the contemporary narrative, or had learned from contemporaries of the facts. The whole sicence of history is based upon the records that have come down to us from the past. We are unable to observe what has taken place in the past ourselves and so are obliged to trust to the narratives of men who have lived in the past for our facts.

We take these narratives and examine them, trying to find out their value as witnesses of the past facts and admits them in accordance with whether we regard them as reliable witnesses of the facts; as to whether they were capable of knowing themselves or through others of the facts which they relate. I had this in mind in reference to Woodruff's History of Will County and the incident which is there referred to.

As to statements of old settlers in reference to that fact, historians of western America are obliged to use as source material in their investigations statements, by old settlers that have come down to us; and these are of as great value as sources, as the material that is used by the historians that have written of Greece, of Rome, and of the Middle Ages where very similar material is at hand, and in fact where material that is not as good as these statements by old set-

tlers is used by historians.

That is the general method in which the authoritative histories in western countries have been written. The quotation from the volume "Illinois in 1837," just read, shows that when that volume was produced the fur trade in Northern Illinois had come to an end. With the close of the Black Hawk War and the transportation of the Indians in Northern Illinois across the Mississippi river, the hunters that had up until this time supplied the furs to the traders were no longer in existence in the region, and therefore there was no prospect of large profit open to traders, and the fur trade in the region came to an end.

The passing of the Indians from Northern Illinois opened the territory to immigration, and large numbers of farmers came in, men of different experience than the fur traders, with different demands. The northern portion of Illinois was quickly settled and agitation was immediately begun for transportation such as they were familiar with. The agitation was first for a canal and later for railroads and these were built and the old routes by which trade had been carried, passed out of the memory of man. As a matter of historical fact, the kind of motive power employed had something to do with the agitation for a different artery of commerce. The connection between the two was that steamboat navigation was introduced. The method of traveling on the deeper rivers by steamboats created a demand for rapid transportation, and the use of the steamboats on the lower Mississippi made of St. Louis one of the chief markets of the fur traders; traders sent their furs in that direction and down the Mississippi and through the Gulf of Mexico to Europe instead of using the old avenues of trade. St. Louis, of course, grew very rapidly after the introduction of the steamboats, and its chief history as a fur center dates from that time.

EXTRACT FROM LECTURE OF JOHN WENTWORTH.

Referring to the book now shown me, entitled "Fergus Historical Series, parts 6-9," it contains several articles which are bound into the volume. Number 7 is entitled "Early Chicago by Hon. John Wentworth," The title page reads "Early Chicago," a lecture delivered before the Sunday Lecture Society at McCormick Hall, on Sunday afternoon, May 7th, 1876, by Hon. John Wentworth, late Editor, Publisher and Proprietor of the 'Chicago Democrat,' the First Corporation Newspaper; Member of Congress for the Chicago District for twelve years; two terms Mayor; and a Settler of 1836."

I find in that article a reference to the Chicago and Des-

plaines river, on page 7 as follows:

"Their route out of Chicago was down the north fork of the south branch through Mud Lake, then called la petit lac, to the Desplaines river, and generally in the same little boats with which they had passed over the lakes of the east. This route, partially interrupted by the construction of the Illinois and Michigan Canal, has been recently restored to the condition it occupied for so many hundred years, and the waters of Lake Michigan and of the Desplaines river again mingle, after a few years of unnatural separation."

EXTRACTS FROM THE NARRATIVE AND CRITICAL HISTORY OF AMERICA.

(Prof. Alvord continuing):

The volume which is now shown me is entitled "Narrative and Critical History of America, Edited by Justin Winsor, Librarian of Harvard University, Corresponding Secretary Massachusetts Historical Society. Volume V. Boston and New York. 1887."

Justin Winsor is regarded by historians as one of the greatest historians that America has produced; and this particular work of which he was general editor is one of the monuments of American scholarship. All parts of it are of course not by Winsor himself. It was prepared under his supervision and issued with his authority.

I find in that volume an article referring to this river route, on page 1 of Volume V, beginning at a chapter called "Canada and Louisiana, by Andrew McFarland Davis, American Anti-

quarian Society." On page 7 of that chapter there is con-

tained the following statement:

"As the trade with the Valley of the Mississippi developed routes of travel began to be defined. Three of these were especially used,—one by way of Lake Erie, the Maumee, and the Wabash, and then down the Ohio; another by way of Lake Michigan, the Chicago River a portage to the Illinois, and down that river; a third by way of Green Bay, Fox River, and the Wisconsin—all three being independent of LaSalle's route from the foot of Lake Michigan to the Kankakee and Illinois rivers." (Prof. Alvord continuing):

In Volume 4 of this same history I find a reference to this river route on page 198, which is an editorial note written by Justin Winsor himself. The particular extract occurs on page 224, note 1, as follows (4 Narr. & Crit. Hist., 224, n. 1):

"The principal portages by which passage was early made by canoes from the basin of the lakes to that of the

Mississippi were five in number.

 By Green Bay, Lake Winnebago, and the Fox River to the Wisconsin, thence to the Mississippi, the route of Joliet.

2. By the Chicago river, at the southwest of Lake Michigan to the Illinois, thence to the Mississippi. This appears in the earliest maps of Joliet and Marquette, and is displayed in the great 1684 map of Franquelin of this part of which Parkman gives a drawing in his LaSalle, which with various later ones is repeated in Hurlburt's Chicago Antiquities.

3. By the St. Joseph river, at the southeast corner of Lake Michigan, to the Kankakee and so to the Illinois.

This was LaSalle's route.

4. By the St. Joseph's river to the Wabash (Qua-

bache); thence to the Ohio and Mississippi.

5. By the Miami River from the west end of Lake Erie to the Wabash; thence to the Ohio and Mississippi."

EXTRACTS JUSTIN WINSOR "THE MISSISSIPPI BASIN,"

(Prof. Alvord continuing):

The book which is now shown me is by the same author, Justin Winsor, and is entitled "The Mississippi Basin. The Struggle in America between England and France. 1697-1763. With Full Cartographical Illustrations from Contemporary Sources by Justin Winsor, Boston and New York. 1895."

I find in this book the following reference to this river route.

at page 24:

"Before the end of the seventeenth century, the portages at the head of Lake Michigan had become the best known of all, and there had been a trading-post for something like fifteen years at the Chicago River. What Herman Moll, the English cartographer called the 'Land carriage of Chekakou' is described by James Logan, in a communication which he makes in 1718 to the English Board of Trade as running from the lake three leagues up the river, then a half a league of carriage, then a mile of water, next a small carry, then two miles to the Illinois, and then one hundred and thirty leagues to the Mississippi. But descriptions varied with the seasons. It was usually called a carriage of from four to nine miles, according to the stage of the water. In dry seasons it was even farther while in wet times it might not be more than a mile; and, indeed, when the intervening lands were 'drowned' it was quite possible to pass in a canoe amid the sedges from Lake Michigan to the Desplaines, and so to the Illinois and the Mississippi."

EXTRACTS HINSDALE "THE OLD NORTHWEST."

(Prof. Alvord continuing):

The book to which I next refer is entitled "The Old North-With a View of the Thirteen Colonies as Constituted by the Royal Charters. By B. A. Hinsdale, Ph. D., Professor of the Science and Art of Teaching, University of Michigan: Author of 'Schools and Studies' and Editor of 'The Works of James Abram Garfield.' New York, 1888."

Historians generally praise this work very highly and use it as the chief secondary source of their knowledge for the history of the period, which it covers. It is again and again referred to in Hart's American Nation Series, which is the latest and probably the most authoritative history of the

United States.

I find in this work a reference to this river route by way of

the Chicago and Desplaines, on page 44 as follows:

"The French located their principal missions and posts with admirable judgment. There is not one of them in which we cannot see the wisdom of the priest, of the soldier, and the trader combined. The triple alliance worked for an immediate end, but the sites that they

chose are as important today as they were when they chose them. The fact is, nature had decided all these questions ages before the soil of the New World had been pressed by the white man's foot. Marquette called the Straits of Mackinaw 'the key, and as it were, the gate for all the tribes from the south as the Saut is for those of the North, there being in this section of the country. only these two passages by water, for a greater number of nations have to go by one or other of these channels. in order to reach the French settlments. This presents a peculiarly favorable opportunity both for instructing those who pass here and also for obtaining easy access and conveyance to their places of abode.' The straits were called the 'Home of the fishes.' 'Elsewhere although they exist in large numbers,' says Marquette, 'it is not properly their home, which is in the neighborhood of Michilimackinac. It is this attraction which has heretofore drawn to a point so advantageous the greater part of the savages in this country, driven away by fear of the Iroquois.' LaSalle's colony of St. Louis was planted in one of the gardens of the world in the midst of a numerous Indian population, on the great line of travel between Lake Michigan and the Mississippi River, Kaskaskia and the neighboring settlements held the centre of the long line extending from Canada to Louisiana. The Wabash colony commanded that valley and the Lower Ohio. Detroit was a position so important, that, securely held by the French it practically banished from the English mind for fifty years the thought of acquiring the Northwest. The Indians and the beavers have long since disappeared from the region lying between the lakes and the Mississippi; that region has twice changed hands since those early days; the whole country has been transformed by the hand of man; but the Saut Canal, the Mackinaw shipping, and the cities of Chicago, St. Louis and Detroit show us how geography conditions history as well as that the savage and civilized man have much in common. Then how unerringly were the French guided to the carrying places between the northern and the southern waters, viz, Green Bay, Fox River, and the Wisconsin; the Chicago River, and the Illinois; the St. Joseph and the Kankakee the St. Joseph and the Wabash; the Maumee and the Wabash; and, later on, on the eve of the war that gave New France to England, the Chautaqua and French Creek routes from Lake Erie to the Ohio."

PROFESSOR FARRAND'S BOOK ON AMERICAN NATION SERIES.

(Prof. Alvord continuing):

The volume now shown me is a volume of the American Nation Series edited by Professor Farrand. This particular volume is regarded as one of the best of this series, and the series as a whole edited by Professor Hart is regarded as the most authoritative history of the United States that we possess, up to this time. Professor Hart is a professor of Harvard University. Just for the moment it has slipped me what institution Professor Farrand is connected with, but it can easily be found in the book.

The passage in question is as follows:

"From the Great Lakes to the Mississippi basin there was a choice of paths. In the Northwest the French often crossed from the head of Lake Superior to the upper Mississippi by way of St. Louis River. The most important portage, however, was probably that which led from the Fox to the Wisconsin River, first used in 1673 by Joliet and Marquette, and later the site of Fort Winnebago. At the southern end of Lake Michigan an important trail led from the Chicago to the DesPlaines and so to the Illinois, on the same line as the present Chicago Drainage canal; the portage was from four to nine miles in length according to the season. Other carrying-places of that region were from the Calumet to the DesPlaines and from the St. Joseph to the Kankakee; but that from the St. Joseph to the Wabash was the principal channel of supplies from the early settlers at Vincennes."

EXTRACTS FROM SMITH'S HISTORY OF WISCONSIN IN 1854.

(Prof. Alvord continuing):

The book which is now shown me is entitled "The History of Wisconsin in three parts, Historical, Documentary, and Descriptive. Compiled by Direction of the Legislature of the State. By William R. Smith, President of the State Historical Society of Wisconsin. Part 1—Historical. Vol. 1. Madison, Wis., 1854."

This is regarded by historians as one of the best of the local state histories in the west. I know of no other book entitled "Smith History of Wisconsin." This is the volume referred to by the Supreme Court of the United States in the Mon-

tello case, in the 20th Wallace.

I find in this book a reference to this river route as follows: "One among the first of the operations of the Western Company was to send eight hundred emigrants to Louisiana; they arrived in August, 1718, at Dauphine Island. Bienville had in the midsummer of the same year, selected the site for the capital, of the new empire, which in honor of the regent of France, he named 'New Orleans.' Of the recent emigrants from France, eighty convicts were sent among the coppices that overspread New Orleans, to prepare room for a few tents and cottages. At the end of three years the place was still a wilderness spot where two hundred persons, sent to construct a city, had but encamped among unsubdued cane-brakes. The character of the emigration was not that of industry, energy, or of information; some perished for want of enterprise, some from the climate; and in place of ascending the river in ships, they all blindly disembarked on the miserable coast, to make their way as best they could to the lands that had been ceded to them. An extraordinary instance of energy may be mentioned: DuTissenet, a Canadian emigrant, having purchased a compass, and procured an escort of fourteen Canadians, went fearlessly from Dauphin Island by way of the Mobile River to Quebec, and returned to the banks of the Mississippi with his family. At this period the three great avenues from the St. Lawrence to the Mississippi were, one by way of the Fox and Wisconsin Rivers; one by way of Chicago, which had been safely pursued since the days of Marquette; and one by the Miami of the Lakes, where after crossing the portage of three leagues over the summit level, a shallow stream led into the Wabash and the Ohio."

Conclusions of Professor Alvord.

Q. Now, having in mind the investigation which you have made, the different historical authorities to which you have called attention, what do you state to be your judgment as a historian with reference to the fact as to whether the Desplaines river at the point at which the dam in question in this case is being constructed, was in its natural condition actually used in the carrying on of trade and commerce?

A. As a historian, I would answer the question as follows: Giving due weight to all the sources of information that are available, my opinion is that from the latter part of the 17th century through the first third of the 19th century, men engaged in the fur trade passed up and down the Chicago and Desplaines rivers in canoes and flatboats very regularly; that the fur trade was pursued by the French as long as they held possession of this country; was developed more fully by the English and later by the Americans. That the most active trade carried on the two rivers falls between the period of 1783 and 1825, or thereabouts; that the traders found a very easy passageway by means of these rivers in the early spring. That during the time of drought such as occurred in the summer or fall, the passage was hard, but even then they forced their boats through the waterway, often being obliged, however, to carry their packages around the shoals and rapids.

Q. Have you found in the investigation which you have made in any historical work, that in your opinion is entitled to weight, a statement to the effect that during the period with reference to which you have just testified this Chicago-Desplaines route was not used for the purpose which you have

stated?

A. I have not found any historian writing of the situation in the west competent to pass judgment upon material, and who had investigated material, that denies that the Chicago and Desplaines rivers were so used.

CLIPPINGS FROM LETTERS OF EBENEZER FLAGG, 1818.

The document now shown me consists of clippings from the Alton Weekly Telegraph, the first beginning Thursday morning, April 27, 1876, and continuing for nine weeks thereafter.

The editor in explanation writes:

"Hon. W. C. Flagg has kindly placed at our disposal a number of letters written by his father, between fifty and sixty years ago. They are entitled 'Early Letters of an Early Settler' and will appear as a part of the Telegraph's Series of Pioneer Papers. The letters are nine in number and will appear under the following titles": He then gives the nine titles.

"The first part of the letter appears in this number. Such of our readers, and there are many, who are interested in the pioneer history of the west, will be much interested in the 'Early Letters of an Early Settler.' "

(Prof. Alvord continuing):

These clippings were taken from the Alton Weekly Tele-

graph, published at Alton, Illinois, a well-known weekly paper of Southern Illinois.

The title of the article is: "Pioneer papers. Early Letters of an Early Settler," written by Gershom Flagg. Gershom Flagg's son, W. C. Flagg, states in the first clipping that he was the son of Dr. Ebenezer Flagg and a descendant, in the 7th generation, of Thomas Flagg.

Whereupon the witness was asked to read from the papers

what was stated therein concerning Gershom Flagg.

Said extract so requested was read into the record, as fol-

lows:

"Gershom Flagg, son of Dr. Ebenezer Flagg and a descendant, in the seventh generation, of Thomas Flagg, who emigrated from Norfolk, England, in 1637, and settled in Watertown, Mass., in 1641, was born in Orweel, Vermont, November 26, 1792, removed with his father's family to Richmond, Vermont, about the year 1800, and in 1816 at the age of 24, started west."

(Prof. Alvord continuing):

As to what I know personally of Gershom Flagg I would say, that Gershom Flagg finally settled in Madison County, Illinois, where he lived and where his descendants are now living. He was a well-known man of his age, as was his son

and is his grandson today.

As to the standing of the articles of Gershom Flagg among historians in general, they would only have the standing of source material, as emanating from a pioneer of the west who had come into this region and made observations and written concerning them, letters. Such material is regarded always by historians as of the very best, as being first class, primary source material.

Q. Do you find in there any reference to the use of the Desplaines river for the purpose of navigation or as a water-

way? State where it is found and what it is.

A. I find a reference to the use of the Desplaines river for the purpose of a waterway in the fifth article, entitled "Madison County, in 1818." These pioneer papers were published in the Alton Weekly Telegraph, beginning April 27, 1876, and appeared every week thereafter for nine weeks. In the fifth contribution, entitled "Madison County, in 1818," headed "Edwardsville, Madison County, Illinois ter. 12 Sept. 1818," is a passage concerning advantages for transportation; which passage is as follows:

"The situation of this territory is good for trade, hav-

ing the advantage of water carriage on all sides. The Mississippi on the west, the Ohio and Wabash on the southeast and the Kaskaskia and Illinois in the interior of the territory. The Illinois, which is about 400 miles in length and heads near Lake Michigan. A branch of the Illinois heads within 4 miles of the head of the Chicago, a short river which empties into Lake Michigan. In freshets boats pass this portage, the waters being connected. They are made shallow for the purpose. I have seen them at St. Louis landing. I think there will be a canal cut to connect the waters of Illinois and Chicago at no distant From information the expense would not be period. great. One hundred thousand acres of land is appropriated for this purpose. This done, we have a water communication from almost any part of the territory to the States of Indiana, Ohio and Pennsylvania, on either side of these States. Also with New York by way of Lake Erie, and an easy communication with the ocean by New Orleans."

PROFESSOR A. C. McLAUGHLIN, called as a witness in the suit above referred to as a witness for the government, testified:

My full name is Andrew Cunningham McLaughlin. I live at 5609 Woodlawn avenue, Chicago. My occupation is that of professor and head of the Department of History in the University of Chicago. I have held that position four years and a half. Prior to that time I was a professor of American History in the University of Michigan since 1891. Prior to that I had been an assistant professor of history for three years, I think it was. Two years of the time when I was professor of history at the University of Michigan I was absent in charge of the Bureau of Historical Research of the Carnegie Institute at Washington. I have been associate editor of the American Historical Review for twelve years. Four years of that time I was managing editor of the American Historical Review from 1901 to 1905. I am a member of the American Historical Association; the Illinois Historical Society; corresponding member of the Massachusetts Historical Society; Wisconsin Historical Society and the American Antiquarian Society. In connection with my profession, I have written a number of historical articles and books. The principal ones would be the Life of Lewis Cass for the American Statesman Series, which I wrote about twenty years ago; an article on the Retention of the Western Coast by the British in 1783; a history of the American Nation so called, a text-book for schools; The Confederation and the Constitution, one of the volumes of the American Nation Series, published by Professor Hart; and various other arti-

cles for magazines and journals.

My department of historical research and writing has been American history in general, though I have specialized more particularly in American constitutional history. I have done some work in western history, more especially some years ago, and have overlooked the work of advanced students in the question of history to some extent. I have made a special study with reference to the methods which I used in historical research and the methods which historians use to arrive at a conclusion with reference to historical facts. I have studied books on historical methods and especially in my connection with teaching historical methods to students I have made special preparation in various ways; I have studied the methods of historical writers and I have been called upon as editor of the American Historical Review for years to examine critically articles that were sent in for publication. The object in view when I studied and made a review of these articles was to discover whether proper historical methods were used and the material handled properly, and the conclusions that were reached appeared justifiable and whether the articles were new and proprly put together and acceptable in general. One of the things which I have tried to determine has been the accuracy of the statements which appeared in those articles. There is a branch of writing in connection with the study of history and the methods of historical research which is devoted to the methods of history and there are well-recognized authorities which I have made a study and investigation of. The chiefest authority is Bernheim, Lehrbuch der Historischen Methode. Almost as well known though not as complete is Langlois and Siegnobos, introduction to the study of history. I know it in translation. George's Historical Evidence. Those are the chief things that I have in mind.

The classes of material recognized by students of history are classified commonly as source and secondary authorities. The historical investigator seeks to come just as near a fact which he is endeavoring to establish in time and place as possible. In doing so he uses the sources. In many cases in making such an investigation we may rely upon monographic material which is strictly secondary authority, but the historical investigator seeks to go to the sources technically so called. To define what I mean by sources: sources is a translation of the German word "quellen" and it means, of course, the headwaters and the actual source of a stream of information. It is defined by Bernheim in some such way as this, and this I should say would be the proper definition:

"Sources are the relics of the past which enable us to reconstruct the past; those sources or relics either being purposely intended for the purpose of enabling us to know what went on in the past, or by nature adapted to

such purpose."

The historical student seeks if possible to reduce every statement so far as he can to an actual observation and in order to do that he endeavors to get just as near to the facts as he can. As a matter of fact he often has to use very insufficient observations at times and he does not always have at his hand facts that are stated by participants in events or in those facts, or those that have actually seen the occurrences. The consequence is that there is a somewhat loose definition of different classes of historical sources. In the first place, they are the actual relics or survivals of the past activities of man. These include not only buildings, very evident tangible survivals of that kind, but books of account and papers of that kind which generally do not need to be submitted to the ordinary tests of psychological character. These first are commonly called the unconscious sources, though there might be other unconscious sources that would not come under this definition of survivals or ueberreste, as the Germans call it.

In the second place, we would have the account of a contemporary who knew of his own knowledge what happened,

the events which he narrates.

In the third place, we should have accounts by a contemporary who very evidently and distinctly based his evidence upon the knowledge of others and upon the reports of others.

Also, in the next place, we have accounts that are not strictly by contemporaries but by persons much nearer the events in time and place than we are and who seem to have had opportunity for ascertaining those facts. These are not strictly primary sources and are necessarily subjected to a much closer criticism, perhaps used with more doubt in general than are the other classes of sources of which I have spoken.

A contemporary map might be an actual description of what one himself had actually seen. If so, it would come under the second general division that I have marked here.

Otherwise it would be under the third,

We might have maps which appear to us trustworthy which would be classified under the fourth of these general divisions which I have given, made by a man who had the reputation of being a careful map maker and seemed to have materials for reaching his conclusions that we do not have. Those would naturally be included under the fourth of these general divisions. I think, however, we should call those sources if they were not strictly contemporary but nevertheless of the general character I have described. It must be confessed when we get over into the fourth of these divisions our classifications is somewhat loose and I think that

is true generally of the writers on this subject.

Having in mind the method of historical study and research which I have briefly outlined, and having in mind my experience as an investigator of historical subjects, I would state as the method that the historian would follow in seeking to ascertain whether or not a certain river, the Desplaines River for instance, was at any time used for purposes of trade and commerce, as a historian I should myself use the well recognized secondary authorities, first in order to get my general bearings and get the assistance of reference and other guidances of that sort. Then I should proceed to examine the accounts of men who had actually used the river as a route of trade and commerce, if any such could be discovered. I should also endeavor to discover statements by contemporaries concerning the use of that river even if they had not been actual users of it themselves. I should examine the maps and the gazetteers and the books of travel written or prepared by persons on whose general judgment and observation I felt I could rely.

As to classifying different books as accurate and inaccurate, and rejecting any of them with reference to determining whether each one was accurate or inaccurate, I would say that the historian commonly does not classify books in that way when he is endeavoring to establish a historical fact. Nothing is better established than that a single primary source may be trustworthy in some respects and untrustworthy in others. If the matter was in doubt he would subject the

source to various tests and see whether there were any reasons for doubting one portion and accepting another. When I said "on which I could rely," if a person is well known as a careful writer, if he appears to have a capacity for careful observations, his conclusions are naturally accepted with more force than if he appeared to be a careless observer or writer. But the statements of a person who is guilty of inaccuracies are not necessarily rejected if they appear on

the whole to stand the test of the examination.

As to the standing of county histories, I should say that there are all kinds of county histories and town histories. Some of them are of the very highest quality. In general, however, the writer of a county or town history is not a trained historian and is likely to accept or is not unlikely let me say, to accept facts without the careful examination that the trained historian would accept them under. At the same time, those writers have access to a kind of material which the general historian cannot have access to and in many respects these town histories include material that is strictly source material and which the historical student necessarily uses and often uses with gratitude to the writer of these books. So that, in making a historical investigation of a given subject. I make use of incidents which I find referred to in material of that kind, giving to a particular reference the weight to which from all the circumstances it appears to be entitled. So that with reference to a particular statement that is found in the books there might be a distinction between the weight given to that statement and the weight given to the book as a whole.

CONCLUSION OF PROFESSOR A. C. McLAUGHLIN.

Referring now to the period from the time of Charlevoix to the year 1825, and basing my answer upon the sources of historical information to which my attention has been specifically directed, assuming that as a historical writer I was preparing a history of Illinois, concerning the use of the Desplaines River, I should say that the Desplaines River was used with apparently considerable frequency as a route of trade and commerce; that at certain seasons of the year it seemed to have presented some difficulties, other seasons of the year it was used with considerable ease, and that it was a well known means of communication between the lake region and the lower Illinois and Mississippi.

I know Mr. Alvord who testified in this case most favorably as an historian. I have had occasion in my extended historical work to come in contact with his work.

DR. REUBEN GOLD THWAITES, called as a witness in the case above referred to in behalf of the Government, testified:

I reside at Madison, Wisconsin. In the past twenty-four years I have been Secretary and Superintendent of the State Historical Society of Wisconsin. A part of my duties as Superintendent of what we shall call the Wisconsin Historical Society for a short cut, is to conduct investigations of the

society and superintend its publications.

I am a member of the Wisconsin Historical Commission; also its secretary and the editor of its publications. I am a lecturer on American History in the State University of Wisconsin, my special field being the period of discovery, exploration and settlement of the basin of the St. Lawrence, the Great Lakes and the Mississippi River, from the period of earliest discovery to about the year 1850. I also give a course at the University on historical methods, especially with reference to the preparation of manuscript material for publication. I will say that in the course of preparation for these duties that I have mentioned, I have been obliged to make a study of source material, especially upon the history of the French occupation of North America from 1604 to 1763; and of the British occupation of the West from 1760 to 1816; and later, the American occupation of the West from 1776 to about the year 1850.

I will say that in the consultation of original sources I have sought access to all the material I could obtain, both printed and manuscript, concerning this region and this period that I have mentioned. I have spent much time in personal investigation of the various scholarly centers where such original source material is kept, including many of the official archives in Canada, in the United States, and to some extent in Europe, particularly Paris. I have also had a great many personal interviews with large number of voyageurs and fur traders and English and American pioneers in this region.

As a result of these various investigations and studies, I have published the following works as author: "Down Historic Waterways," in 1888; "The Story of Wisconsin," in 1890; "The Colonies" (meaning the American Colonies),

"from 1492 to 1750." That was published in 1891. "On the Storied Ohio," in 1897; "Stories of the Badger States," in 1900; "A History of the University of Wisconsin," in 1900; "The Life of Father Marquette," in 1902; "The Life of Daniel Boone" in the same year, 1902; "How George Rogers Clark Won the Northwest and other Essays in Western History," in 1903; "A Brief History of Rocky Mountain Exploration," in 1904. The volume entitled "France in America" in the American Nation Series, in 1905; and the volume entitled

"Wisconsin" in the Commonwealth Series, in 1909.

I have edited the following works: "Volumes 11 to 19 of the Wisconsin Historical Collections." These have been published between the years 1908 and 1910; the 1910 volume is just out. "Chronicles of Border Warfare," in 1895; "The Jesuit Relations and Allied Documents," published in 73 volumes between 1896 and 1901; "Mrs. Kinzie's Wau-Nun," a reprint published for the Caxton Club of Chicago, in 1901; "Early Western Travels from 1748 to 1846," the series published in 31 volumes between the years 1904 and 1906; "Hennepin's a New Discovery" published in two volumes in 1903; "Lahontan's New Voyages to North America," a series of two volumes published in 1905; "Documentary History of Dunmore's War," in 1905; and the "Original Journals of the Lewis and Clark Expedition," published in eight volumes in 1904 to 1906. "The Revolution on the Upper Ohio, from 1775 to 1777" published in 1905.

In addition to the above, I have prepared and edited numerous monographs, magazine articles, and public addresses bear-

ing upon my particular field of study.

I served for a time as Chairman of the American Historical Manuscript Commission, which is one of the activities or branches of the American Historical Association; I have also been a member of the council of the American Historical Association, and am at present a member of its committee on Historical Sites in the United States. I am a member of the American Antiquarian Association, corresponding member of the Massachusetts Historical Society, and am either an honorary or corresponding member of a large number of like associations and societies in the United States and Canada, some fifty in all I believe. Among these I may mention the historical societies of Minnesota, Illinois, Michigan, Chicago, Mississippi Valley, Ohio Valley, and the Southern Historical Association.

It is a fact that some of these societies elect members sim-

ply because of the actual work that those member have done in the field of historical research. The American Antiquarian Society is an organization of that character. I am a member of that society. The corresponding membership list of the Massachusetts Society falls under the same category. I have been a corresponding member of that society some ten years back.

I am superintendent, practically librarian, of the Wisconsin Historical Society. I was president of the American Library Association for the years 1899 and 1900.

ADDITIONAL EXTRACTS FROM LIFE OF GURDON S. HUBBARD.

Prof. Thwaites (continuing):

Referring to a book which I hold in my hand entitled "Incidents and Events in the Life of Gurdon Saltonstall Hubbard, collected from personal narrations and other sources, and arranged by his nephew, Henry E. Hamilton," published at Chicago in 1888, being the book from which extracts have already been introduced into the record, I would say that this narrative of Mr. Hubbard's, from which this book is for the most part made up, appears to have been written about the year 1880. I gather this from a sentence from page 11, of that book, wherein he says:

"Though sixty-two years have passed since then, I distinctly remember the animating and affecting scene

presented that morning."

He here refers to an event which occurred in the year 1818. Mr. Hubbard had been engaged in the fur trade in Northern Illinois for a long term of years; his personal reminiscences, therefore, constitute a history of that trade, in this region, so far as his personal experience brought him into touch with that commerce?

On page 10 of his life, I learned that he was first engaged by the American Fur Company in the spring of 1818. He described upon that page the nature of his outfit, his wardrobe, and the other articles necessary to take with him, and he says:

"On the 13th of May, 1818, having bid adieu to my mother and sisters, I started with my father and brother for Lachine, where I arrived about nine o'clock in the

morning and reported for duty."

The American Fur Company, of which John Jacob Astor was the moving spirit, was at this time conducting a wide-spread commerce with the Indians for furs throughout the entire region of the upper Great Lakes, the upper Mississippi Valley and the upper Missouri Valley. This company was the

dominating force in the fur trade of this vast region. Their chief distributing point in the west was upon the Island of Mackinaw. Upon this island they had their general offices and large warehouses to which they transported in sailing vessels the merchandise which they took into the west for the purpose of exchanging with the Indians for furs. From Mackinaw Island they sent out brigades or crews of fur traders to visit the outlying fur trading posts upon the upper Great Lakes and the rivers of the west and the northwest. The fleets of boats were propelled by engages or voyageurs and there were at the head of such fleets one or more clerks or bourgeois.

Upon page 21, Mr. Hubbard says:

"The force of the company when all were assembled on the island, comprised about four hundred clerks and traders, together with some two thousand voyageurs."

At Mackinac Island the brigades as they were for the most part called, were provisioned and equipped and otherwise made ready to go to the particular trading territory assigned to each brigade.

On page 24 Mr. Hubbard describes one of these brigades in

the following language:

"The 'brigade' destined for the Lake of the Woods, having the longest journey to make, was the first to depart. They were transported in boats called 'Batteaux,' which very much resembled the boats now used by fishermen on the Great Lakes, except that they were larger, and were each manned by a crew of five men besides a clerk. Four of the men rowed while the fifth steered. Each boat carried about three tons of merchandise, together with the clothing of the men and rations of corn and tallow. No shelter was provided for the voyageurs, and their luggage was confined to twenty pounds in weight, carried in a bag provided for that purpose."

On the same page Mr. Hubbard further says:

"The clerks were furnished with salt pork, a bag of flour, tea and coffee, and a tent for shelter, and messed

with the commander and orderly."

On page 25, Mr. Hubbard states that he was at first detailed to the brigade headed for Fond du Lac of Lake Superior,—that is, the bay on which is today situated the City of Duluth, Minnesota. But about this time he says that he received a letter from his father to the effect that his father and brother were to be in St. Louis and that the commander of the

"Wabash and Illinois outfit" always sent a boat to St. Louis to purchase supplies for his various fur trading posts. For this reason Mr. Hubbard asked to be assigned to that brigade and his request was granted.

On page 23 I learn that the commander of the "Illinois brigade" was Mr. Deschamps. Mr. Hubbard says of Mr.

Deschamps:

"He at the age of nineteen engaged himself to Mr. Sara (by whom he meant Gabriel Cerre), a fur trader at St. Louis, and had devoted many years of his life to the Indian trade on the Ohio and Illinois Rivers. When the American Fur Company was organized he was engaged by them and placed in charge of the 'Illinois brigade' or outfit."

I will now follow the first trip made by Mr. Hubbard. On page 28 of the book before us there is this description by Mr.

Hubbard of the Illinois brigade:

"Some of our boats were crowded with the families of the traders, the oldest of whom was Mr. Bieson, a large, portly, gray-headed man, who was then about sixty years of age, and for more than forty years had been an Indian trader on the Ohio, Mississippi and Illinois Rivers. His wife was a pure-blooded Pottawatomie Indian, enormous in size—so fleshy she could scarcely walk."

On page 29, Mr. Hubbard, says:

"Among the others, who had with them their families were Messrs. Bebeau of Opa, (meaning Peoria), and Lefrombois, Bleau, and LeClare all of whom had Indian wives; and, in fact, there were but three or four single men in the party."

On page 59 of Mr. Hubbard's book, I find the following

phrase:

"The next day we spent in loading our boats and the day following the thirteen boats of the 'Brigade' pushed off from the shore, and, to the music of the Canadian boatsong we started on our long return journey."

Returning now to page 30, I learn from Mr. Hubbard's ac-

count that:

"The boats progressed at the rate of about forty miles per day under oars, and when the wind was fair we hoisted our square sails, by the aid of which we were enabled to make seventy or seventy-five miles per day. If the wind proved too heavy, or blew strong ahead, we sought an entrance into the first creek or river we came to,

and there awaited a favorable time to proceed. If caught by a storm on the coast, when a shelter could not be reached, we sought the shore, where our boats were unloaded and hauled up onto the beach out of reach of the surf. This was a hard and fatiguing labor, and was accomplished by laying down poles on the sand from the edge of the water. The men then waded into the water on each side of the boat, and by lifting and pushing as each large wave rolled against it, finally succeeding in landing it high and dry on the shore."

Mr. Hubbard's narrative then proceeds to give details of the route followed until they reached Chicago, October 1, 1818,

which event he records on page 32, saying:

"Thus I made my first entry into Chicago, October 1, 1818. We were met upon landing by Mr. Kinzie, and as soon as our tents were pitched, were called upon by the officers of the fort, to all of whom I was introduced by Mr. Deschamps, as his boy. I presented my letter of introduction to Mr. Kinzie and with it a package sent by his son."

We come now to the long description of the route taken by this expedition from Chicago to the Illinois River. I will not read this, however, because I find it in the transcript of The account of this Professor Alvord's examination. page the portage commences on across The month was October. Hubbard's book. The traders found the crossing of the portage very difficult at that season of the year, there being but little water available for the purpose of floating the boats. Having reached the Desplaines they were able to resume the voyage on the water as far as Isle la Cache, which I have been informed, is the Romeo Island of to-day. Here Mr. Hubbard says, on page

"Low water compelled us to again unload our goods in order to pass our boats over the shoal that there presented itself."

From this point the progress of the expedition was slow,

for according to Hubbard on page 43:

"Most of the distance to the Illinois River our goods were carried on our backs, while our lightened boats were pulled over the shallow places, often being compelled to place poles under them, and on these drag them over the rocks and shoals."

In Professor Alvord's redirect testimony, I find that

he has quoted a paragraph from page 46 of Mr. Hubbard's book. From this paragraph and from a further citation on page 25, of Mr. Hubbard's book, I find that Mr. Deschamps was in the habit of sending a boat every fall to St. Louis for supplies for his Indian trade. This citation on page 25 is as follows:

"I had before this been told by Mr. Deschamps that he made a trip every fall to St. Louis, with one boat, to purchase supplies of tobacco and other necessaries for distribution among the various traders on the Illinois River."

Apparently one of the boats in the fleet of thirteen with Mr. Hubbard was the boat with which he made his trip this

year.

After spending the winter on the Illinois river, Mr. Hubbard, with the other traders of the Illinois brigade returned by the route that they had come. This is referred to on page 269 of Professor Alvord's direct testimony and is taken from Mr. Hubbard's book, page 29. This return trip was made in the month of March. At that time the water was high and the boats "Heavily laden," as Mr. Hubbard says, were able to go up the Desplaines and after the wind changed to sail from Cache Island to Chicago without portage. This is recorded upon pages 59 and 60 of Hubbard's, and is given or page 269 of Professor Alvord's direct testimony.

The next winter, 1819-1820, Mr. Hubbard did not accompany the Illinois brigade, which was still under Deschamps, but was delegated to the Muskegon river, as is reported in his

book, page 74.

The next winter, that of 1820-1821, was spent on the Kalamazoo river, as indicated on page 96 of Hubbard's. In the winter of 1821-1822 Hubbard was again with the Illinois brigade as recorded upon page 104 of his narrative. It then consisted of twelve boats still under Mr. Deschamps. reaching Chicago the traders found, according to Mr. Hubbard, that the water was unusually low and "in places the Desplaines could be crossed on foot without wetting the sole of the shoe." This was the same year.

On page 105 Mr. Hubbard says:

"We were compelled to carry our goods and effects from the South Branch to the Desplaines on our backs, leaving our empty boats to pass through the usual channel from the South Branch to Mud Lake, and through that to the West End and through the other channel. Having completed the portage to the Desplaines and

encountered the usual fatigues in descending that river, without unusual delay or accident, we reached Bureau Station where I had passed my first winter."

The return to Chicago in the spring of 1822 was made in

April. On page 116 Mr. Hubbard says:

"About the first of April we resumed our journey towards Mackinaw, proceeding leisurely, and reaching

Chicago in due season."

The next winter 1822-1823, Hubbard also went with the Illinois brigade. This time the brigade had a passenger who desired to visit southern Illinois. The record of this trip begins on page 121 of Hubbard's narrative. This is alluded to on page 730 of Professor Alvord's redirect testimony. The travelers proceeded by the usual route to the fur trade posts on the Illinois river. Mr. Hubbard states:

"We encountered the usual trials and hardships be-

tween Chicago and Starved Rock."

This winter proved an unusually good one for the fur

traders and as Mr. Hubbard writes, on page 124:

"We had accumulated more furs and peltries than our boats could carry up the Desplaines River and I was accordingly despatched with four boats loads to Chicago; these I stored with Mr. John Crafts, and returned to the 'brigade,' when we all moved forward on our annual return to Mackinaw. A portion of our furs were shipped from Chicago, for the first time in a small schooner which had brought supplies for the garrison."

During the winter of 1823-1824, Hubbard was again with the Illinois brigade, as is recorded on page 129 of his narrative. Since his destination was the Iroquois river, he decided to try the route thither by the St. Joseph and Kankakee, in order, as he says to "save the remainder of the journey to Chicago, as well as the delays and hardships of the old

route through Mud Lake to the Desplaines."

He, therefore left the rest of the party, who proceeded on

to Chicago, as recorded on page 130 of his narrative.

In the spring Mr. Hubbard proceeded to Chicago, as recorded on page 132 of his narrative, and waited for the rest of the brigade at that fur trade post. In the fall of 1824, Mr. Deschamps resigned his position as commandant of the Illinois brigade and Mr. Hubbard was appointed in his place, as recorded in his narrative, page 136. This is referred to in Professor Alvord's cross-examination.

On page 136 of his narrative, Mr. Hubbard says:

"I now determined to carry out a project which I had

long urged upon Mr. Deschamps, but without success—that of unloading the boats upon their arrival at Chicago from Mackinaw and scuttling them in the slough to prevent their loss by prairie fires until they were needed to reload with furs for the return voyage."

Mr. Hubbard proposed to transport the goods and furs on pack horses. He says in regard to this on the same page 136:

"In this manner the long, tedious, and difficult passage through Mud Lake into and down through the Desplaines river would be avoided, and the goods taken directly to the Indians at their hunting grounds, instead of having to be carried on packs on the backs of the men."

By this I understand that he means that up to this time the traders who actually went among the Indians and visited them upon their hunting grounds had made other trips from the trading posts on foot, with their packs on their backs.

Thus, in 1824 the boats of the American Fur Company for the first time since that company was established in 1816, did not travel by the Desplaines river. Although Hubbard did not use the Desplaines river for the trading boats, he did

use it himself.

In the spring of 1825, as appears from page 140 of his narrative, he went to Chicago on foot to consult with Kinzie about some goods which the latter wished Hubbard to buy for him in St. Louis. When Hubbard, upon this trip, reached Chicago, he found that Kinzie had sent "two men in a canoe" with a list of goods to meet him at Peoria. Hubbard thereon started in another canoe "with an old Frenchman for Peoria," and he writes "we got along without trouble until we reached Peoria Lake." This is referred to in Professor Alvord's redirect testimony, page 731. Hubbard found that his men had a boat all ready, so he started for St. Louis, "where," he writes, "we arrived in due season and without accident worthy of notice. I bought my goods, delivered them at Chicago, and returned as quickly as possibly to my post at Iroquois" (by which he means Iroquois river, a branch of the Kankakee river).

Now, from this analysis of Hubbard's narrative which I have given, I arrive at the following conclusions: From the time of the reorganization of the American Fur Company in 1816, until the year 1824, the Illinois brigade sent out by that Fur Company under command of Mr. Deschamps, came every year to Chicago in the fall. This brigade consisted of a dozen or more boats, each capable of carrying about 3,000 pounds of merchandise, besides the equipment of the crews,

the clerks and their wives. Each fall these boats passed over the Chicago portage to the Desplaines river. In places they found sufficient water to float the loaded boats, but in some other places they were obliged, from insufficiency of water, to unload the boats. Now, I do not find in this detailed account by Mr. Hubbard any evidence that the fur traders were obliged to take the boats from the water in these passages, but they were at times forced to use poles to get them over the rocks and shallows. In the springtime these same boats, heavily laden with furs, returned to Lake Michigan by the Desplaines and the Chicago rivers without difficulty.

TRIP OF GOVERNOR CASS, 1828.

As to whether there is any other passage in the life of Hubbard that throws light on the use of the Desplaines river, I should say there is a passage on page 150. It is an account of a visit to Chicago in the fall of 1828, of Governor Lewis Cass, Governor of Michigan Territory. Governor Cass had been upon a trip to Fort Snelling upon the upper Mississippi river, in search of hostile Winnebago Indians, who had been engaged in an outbreak against United States authority. According to Mr. Hubbard's statement here given, Governor Cass had proceeded from Green Bay up the Fox River and down the Wisconsin to the Mississippi. Upon returning from Fort Snelling, he descended the Mississippi river in a steamboat; then according to Mr. Hubbard:

"On reaching the mouth of the Illinois river, the Governor (with his men and canoes, having been brought so far on the steamer) here left it and ascended that stream and the Desplaines passed through Mud Lake into the South Branch of the Chicago River, thus reaching Chicago."

This exhibits to my mind the fact that the Chicago-Desplaines portage route was well known at this time and that Governor Cass, as a public official used this route as a desirable one to proceed from the Mississippi river to the Great Lakes.

As to the weight historians would give this narrative of Hubbard's including the various references to the use of the Chicago-Desplaines route as a means for trade or travel, I should say that these narratives must be regarded as conclusive proof without reference to other sources, that the Desplaines was frequently used for a number of years by the traders of the American Fur Company for the transportation

of their boatloads of merchandise and furs between Lake Michigan and the Mississippi river.

CONCLUSION OF DR. REUBEN GOLD THWAITES.

Q. Referring now, Doctor Thwaites, to the various sources of historical testimony to which your attention has been particularly attracted in this examination, and limiting your answer to such testimony, having in mind the testimony which you have given as a historian in reference to the value of historical testimony and its various kinds of source material, assuming that you were asked as a historian to determine the question as to whether the Desplaines river at, or near its mouth, was used as a route for trade and travel,

what would your answer be?

A. As an historian I would answer your question as follows: Giving due weight to all of the sources of information that I have examined my opinion is that from the latter part of the 17th century through the first third of the 19th century, men engaged in the fur trade with the western Indians actually and quite regularly passed up and down the Chicago and Desplaines rivers in canoes and batteaux, Mackinaw boats and other boats propelled by oars, or poles, laden with merchandise and furs; that these traders and travelers found a comparatively easy passageway by means of these rivers in the early spring, and sometimes at other seasons that during times of drought such as often occurred in the summer and fall on most of the western portage routes between the Great Lakes and the Mississippi (as, for instance, on the well-known and much-used Fox-Wisconsin portage route) the passage was sometimes difficult; but even then these fur traders appear to have succeeded in forcing their boats over the Chicago-Desplaines waterway, although, perhaps, they were obliged here and there to make some carriage at that time of the year, the length of the carriage varying greatly from season to season, and from year to year, according to the stage of water. *

THE BOUNDARIES OF WISCONSIN.

(Doctor Thwaites continuing):

I am familiar with the early history of Wisconsin and Illinois in relation to the location of the boundary line between those states, and the discussion and the reasons for the settlement of the boundary as it finally was settled. The books which throw light upon the location of that boundary are Volume XI of the Wisconsin Historical Collections, in which there is a monograph of which I am the author, entitled "The Boundaries of Wisconsin." Commencing at page 494 of that volume and of that monograph I particularly consider the southern boundary of Wisconsin, that is, the boundary between Illinois and Wisconsin. I should explain by way of introduction that under the provisions of the Ordinance of 1787 the territory northwest of the River Ohio was to be divided into five states, three of them south of a line running east and west between the latitude of the southern extremity of Lake Michigan, and two of them north of that One by one the states afterwards created south of that latitude induced Congress to grant them lake shore frontage to the north of that prescribed latitude. I then go on to state as follows:

"In 1818 Illinois, the third state (meaning the third state to be formed from the old Northwest Territory) applied for entry to the Union. The original bill for the purpose, as introduced by Nathaniel Pope, the delegate from Illinois, provided for the northern boundary prescribed by the ordinance. (Meaning Ordinance of 1787.) But, while his measure was still pending, he appears to have suddenly bethought himself of the advantages of giving to his state a share of the lake coast, and proposed an amendment making the latitude of 42 degrees, 30 minutes, its northern limits. This was a bold move, for the additional strip of territory sought to be thus obtained for Illinois was 61 miles, 19 chains and 13 links in width, embracing a surface of 8,500 square miles of exceedingly fertile soil, and numerous river and lake ports, many miles of fine water power, and the sites of Chicago, Rockford, Freeport, Galena, Oregon, Dixon and

numerous other prosperous cities."
I cite as a footnote as my chief authority for this statement, Ford's History of Illinois, at page 22. "Ford's History of Illinois from its Commencement as a State in 1818 to 1847," was published in 1854. I have a copy thereof before me. The author was Governor Thomas Ford. He died in 1850, before the book was published. In the introduction by General James Shields, General Shields says concerning

Governor Ford:

"The author, during his whole life, had very favorable opportunities for observing events and collecting information connected with the history of his state. He was yet

a child when his parents emigrated to Illinois. On arriving at maturity he was there admitted to the bar, and practiced his profession for many years with very considerable success. He was afterwards elected an associate justice of the Supreme Court of the state, and discharged the duties of that responsible station with distinguished ability. Subsequently he was chosen Governor of the state, which was the last public office he held. From this office he retired to private life, and during his retirement prepared this history for publication."

This book is regarded as one of the prime sources of infromation concerning the history of Illinois, particularly within the period 1818 to 1847 during which Governor Ford was a very prominent citizen and connected with most of the

important public affairs of the State.

Upon page 20, Governor Ford, after setting forth the statement relative to the boundaries created by the Ordinance of

1787, as already outlined by me, writes as follows:

"Judge Pope, seeing that the port of Chicago was north of that line" (meaning the line of latitude impinging upon the southern limit of Lake Michigan as set forth in the Ordinance of 1787), "and would be excluded by it from the State; and that the Illinois and Michigan canal (which was then contemplated) would issue from Chicago, to connect the great northern lakes with the Mississippi, and thus be partly within and partly without the State of Illinois, was thereby led to a critical examination of the Ordinance, which resulted in a clear and satisfactory conviction that it was competent for Congress to extend the boundaries of the new State as far north as they pleased."

Later, upon page 23, he says:

"It therefore became the duty of the national government, not only to make Illinois strong, but to raise an interest inclining and binding her to the eastern and northern portions of the Union. This could be done only through an interest in the lakes. At that time the commerce on the lakes was small, but its increase was confidently expected, and indeed it has exceeded all anticipations, and is yet only in its infancy. To accomplish this object effectually, it was not only necessary to give to Illinois the port of Chicago and a route for the canal, but a considerable coast on Lake Michigan, with a country back of it sufficiently extensive to contain a population capable of exercising a decided influence upon the councils of the State."

PETITION OF LOUVIGNY AND MANTET TO THE FRENCH MINISTER.

(Doctor Thwaites continuing):

Turning to volume IV of Margry, page 9, I would say that this is a petition addressed 17: LeSeiur de Louvigny, captain of the corps of the marine in Canada, formerly commandant upon the upper lakes, and le Seiur de Mantet, lieutenant,

formerly commandant at Chicago.

This petition presented in 1697 to the French Minister of the Marine in Paris, under whose charge the French Colonies then were, is to the effect that Mantet and Louvigny be allowed to make fur trading voyage towards Mexico. Margry found this document in the French archives of the marine. In this document Mantet styles himself: "Former Commandant at Chicago." He asks to be granted "the post of Chicago," which is "the passage to enter into the river of the Mississippi." The date of the memoir is the 14th of October, 1697.

The citation of Mantet relative to his being formerly commandant at Chicago is in the title of the article which of

course would precede it.

The passage on page 16 reads as follows:

"For the purpose of accomplishing these results we entreat his Majesty to grant us the post of Chicago, which is the passage for entering upon the river Mississippi."

WHY WE DO NOT HAVE MORE ACCOUNTS OF THE EARLY USE OF THE RIVERS.

(Doctor Thwaites continuing):

As to why it is that we do not have more accounts of the use of the Desplaines river by travelers or traders, I would say that I can only reply to your question, Mr. Cressy, out of my general knowledge of conditions, the result of a considerable period of time spent in studying this region, especially

during the French regime.

The great majority of the men who were traveling upon the fur trade or as military expeditions and so on, through this northwestern country in the early days were not men who were in the habit of making records of any sort. The most frequent of all the travelers during the French regime were that class of men called coureur de bois, or wood rangers, unlicensed fur traders who were roving all through this country, and who because they were liable to severe punishment because they were trading through the western country without a license from New France, found it greatly to their advantage not to make records or to send out reports concerning their wanderings. It is only now and then that we get little glimpses, occasional references, perhaps, in the reports of missionaries or in letters or reports that have come down to us from military officers and so forth, concerning the presence or the wandering of these coureurs de bois. But a sufficient number of documentary references have come down to us from the past concerning this very large and enterprising and farwandering body of men to give us a pretty good notion of where they were and what they were at, their methods, their life, and so forth.

The Jesuit missionaries were of course men who were obliged under the rules of the Society of Jesus to make reports, to take observations, to send in their reports regularly to their superior officers in Quebec, by whom they were synopsized and forwarded to the general officers in Paris; and this is the reason that we have that great body of information concerning the west that is embodied in the collections known as the Jesuit Relations and Allied Documents.

Relative to military affairs in the west we are only just beginning to get good returns from the various archives of the French in Paris. Considerable quantities of documents have been printed through various channels, such as Margry, New York Colonial Documents, publications of the Michigan, Illinois and Wisconsin historical societies, and so forth; and yet there is a vast amount of material that we have not yet got at, and the American Historical Association is now engaged in making what they hope will be a complete sweep of the archives of France relative to the period of the French regime in North America. The skeleton of Western history has already been built up, although considerable portions of that skeleton have not been produced until quite recent years. Indeed, much of it within the last two or three years.

When we come down to the period of the British fur trade operations we find a somewhat increasing mass of material, and yet the greater part of that has been preserved and has come down to us very largely through accident; some family has preserved a paper, some office somewhere has reserved a letter or a document, but there is no great continuous body of material. What we have is very rich and very suggestive.

When we come down to the early American period the American Fur Company was not an institution which was

making known to the public at large very much of its operations, and yet here and there we do find a letter, a diary, some little journal, some memorandum or something of that kind, that accidentally through the various fortunes that befall historical manuscripts, familiar to historical investigators, has come down to us. I fancy that within the next fifteen or twenty years we shall discover a vast mass of new material for the reason that the various historical publishing agencies of this country, the State historical societies, the American Historical Association, the American Antiquarian Society, and other bodies of that kind, have now reached that condition in their work that they have larger funds to devote to the gathering and editing and publishing of such material than they ever had before, and the historical work is very much better organized, especially within the last five or ten years, than it ever has been before. So that to make the story short when one considers the various vicissitudes that happen to historical papers, the peculiar conditions under which some of these letters and journals were written in the past, I am often very much astonished that as much remains to us as has come down to us; little glimpses now and then, but to the historical student sufficiently illuminating to give us, I think, a pretty good knowledge of what has happened, putting two and two together, reading between the lines, applying to the interpretation of manuscripts one's general historical insight and knowledge,-a pretty good knowledge or picture of the past as it has happened in this western country during the periods of the French, British and American regimes. And yet, as I said, within the next ten years I believe there will be a great body of fresh information that will put the flesh and blood upon the skeleton of western history that has thus far been erected.

Mr. JUDSON F. LEE, a witness for defendant in the above mentioned case, testified as follows:

I have met Ellen Churchill Semple, whose work "American History, and its Geographical Condition" I have cited. She has written a number of articles on this and kindred subjects. She and Turner, and two or three others reported to the American Historical Association on the relation of geography to history, or the economic background of history, which is published in the American Historical Association report. She

gave a course at Chicago University, which I took, wherein she used that particular book. She was on the staff of the university at that time. She has been there two or three times, in the summer. She was not on the regular staff. I only

know the general standing of the book.

The book should be examined with the same tests that are applied to other books which I have put in evidence if there be any question as to the value of the excerpts before they are taken as authority. I would attribute a certain value to it. In that particular book she has attempted to cover a very large subject; I would say that she was a careful writer. I remember a review or two which spoke of it as being a good book; one by Albert Bushnell Hart of Harvard University, who has published widely and has written a number of books; is editor of the American Nation series, and other books and articles. The fact that he reviewed it and said it was carefully written would have weight with me in determining its standing, especially as the review was given in the American Historical Review.

American History and Its Geographical Conditions by Ellen Semple, 22-28-30-159-272.

In "American History, and Its Geographic Condition," by

Ellen Semple, I find the following, page 22:

"Rivers were the only highways into the interior, and up the rivers, preferably those flowing from the north, went the American colonists,—the trapper, trader, and voyageur always in advance." * * * (P. 28):

"The great number of the portages both offered a choice to the traders, especially advantageous in time of war with one or the other of the Indian tribes inhabiting this region, and enormously increased the voyageur's sphere of activity by opening up to him all the country

drained by the Ohio and Mississippi.

The order in which these portages were discovered and used by the French was determined in part by the political neighborhood of the hostile Iroquois along the southern shores of the nearer lakes, and in part by geographical conditions. Up to 1670 the westward route of the canoe fleets was up Lakes Ontario, Erie and Huron to the westernmost outpost at Michillimackinac on the Strait of Mackinaw. This trading station could be reached also

by a more direct northern route from Montreal up the Ottawa river, across to Lake Nipissing and Georgian Bay, -a route which was often used when the Iroquois were on the warpath about Ontario and Erie. Further progress thence naturally led up the waterways afforded by Lake Superior and Lake Michigan to the portages which the Indian described as leading to the western waters. The consequence was that the passages earliest known were those remotest from the Canadian settlements. The first carry route used by the French led from the head of Green Bay up Fox river, across the northern part of Lake Winnebago, and along the upper Fox river for sixty or seventy miles to a narrow portage of two miles, leading to the head of the Wisconsin river. This was the route followed by Marquette and the fur-trader Joliet in 1673, when they explored the Mississippi to the mouth of The other of these earlier portages was the Arkansas. across the narrow lake-dotted watershed between the St. Louis river, which flows into the western extremity of Lake Superior, and the easternmost bend of the Mississippi.

By the end of the seventeenth century the portages at the head of Lake Michigan were the best known. There were a number of these close together. The Chicago river, the lesser and greater Calumet, and the St. Joseph all led by short carries to the Desplaines and Kankakee branches of the Illinois. The Lake Erie portage, though affording nearer, more direct routes by the Ohio tributaries to the Mississippi, came into use only in the eighteenth century, and here too, the progress was from west to east." * * *

(p. 30.) "Having swept westward up the broad highway of the Great Lakes to the upper reaches of the Ohio and Mississippi, the French went to work more slowly to secure all the portages to these rivers and to occupy every strategic point at the extremities of the lakes. Forts Frontenac (Kingston), Niagara, Rouille (Toronto), and Detroit were designed to command the lakes, as Fort St. Louis on the upper Illinois and the post of Outianon on the upper Wabash controlled the Chicago and Maumee portages; while Vincennes, Cahokia, and Kaskaskia completed the line of connection with the lower Mississippi. The vast area thus opened up to the French by their possession of the two great waterways of the continent led to the ultimate shipwreck of their colonial venture, be-

cause the large extent of the territory lured them to exploit its trade rather than make permanent settlements. They spread themselves thin over an enormous area, yielding to the danger of too great expansion." * * *

p. 159.) "Along the Mississippi boundary of Missouri was the gathering of the waters; hither turned the Ohio with its vast tributaries, the Illinois and the Missouri. The Mississippi furnished communication with the Gulf below, and with the Green Bay and Chicago portages above. Missouri was accessible to American settlers from the Lakes to the Gulf and straight across its broad territory ran the natural highway of its own mighty stream."

(p. 272.) "The route of the fur-traders from Lake Michigan down the Illinois, which seemed peculiarly adapted to canalization, early (1816) attracted national attention as a military and commercial waterway between the Mississippi and Lake Michigan. The Massacre at the mouth of the Chicago river in the war of 1812 emphasized the isolation of the northwest lakes. In 1817 Major Long in his report to Congress regarded such a canal as 'first in importance of any in this quarter of the country'; but though projected in 1825, owing to difficulties both technical and financial, it was not opened till 1848, and then proved disappointing as an investment, chiefly because the upper Illinois river needed artificial aid to make it navigable to any but small craft. The same difficulty was present in the waterway of Green Bay, Fox river, and the Wisconsin. The canal connecting the great bend of the Wisconsin with the Upper Fox was only two and one-third miles long, but the sand-bars of the Wisconsin, the shallow, tortuous course of the Upper Fox, and the numerous rapids necessitating canals on the lower river, robbed this waterway of much of its value, and made it succumb rapidly to railroad competition. These western channels over the Great Lakes watershed, being constructed later (1848-53) than the Erie and Ohio canals, because on the frontier of settlement, felt the deadening grip of the railroad before their traffic had been established and suffered moreover the disadvantage of reaching less navigable outlets into the Mississippi river."

HULBERT'S HISTORIC HIGHWAYS PORTAGE PATHS, VOLUME 7.

(Mr. Judson F. Lee continuing):

Q. You referred in your direct testimony, Mr. Lee, to Hulbert's Historic Highways, Portage Paths, Volume 7; in connection with what you read from that volume, I call your attention to pages 180 and 181, and ask you to read the paragraph commencing at the bottom of page 180.

The Witness (reading from Hulbert, page 180):

"The Kankakee-St. Joseph's route was a favorite one for travelers returning from Illinois to the Great Lakes The favorite early 'outward' route was and Canada. from the western shore of Lake Michigan into the Illinois river. Here were two courses: by way of either the Calumet or the Chicago river to the Desplaines branch of the The latter portage was best known and most used. Perhaps no one of the western portages varied more than this in length, as on the best authority it is asserted that sometimes no portage was necessary, and at others a portage of nine miles was necessary; 'The Chicago-Desplaines route involved "a carry" of from four to nine miles, according to the season of the year; in a rainy, spring season, it might not be over a mile; and during a freshet, a canoe might be paddled over the entire route, without any portage.' When Marquette reached the Desplaines, known as 'Portage river' because it offered a pathway to the Illinois, he was compelled to make a portage of only 'half a league.' The course of this portage is practically the present route of the famous Drainage canal which joins the Chicago river with the Desplaines at Elgin, Illinois."

(Mr. Judson F. Lee continuing):
My attention is directed to "Schoolcraft's Journal of Travels from Detroit " to the Sources of the Mississippi

River in the Year 1820."

I read from page 384 an entry purporting to have been made August 30th. I am not sure whether I read what immediately precedes it under date of August 29th.

(Upon request of counsel for complainant, witness read as follows from the entry under date of August 29th.) (Read-

ing):

"Chicago Creek is eighty yards wide, at the garrison, and has a bar at its mouth, which prevents shipping from entering, but is deep within. It is ascended eleven miles in boats and barges, where there is a portage of seven

miles across a prairie, to the River Plein, the main northwestern fork of the Illinois.

The intervening country consists of different strata of marl and clay, presenting great facilities for canal excavation, and the difference in the level of the two streams is so little that loaded boats, of a small class, may pass over the lowest parts of the prairie, during the spring, and autumnal freshets. But at mid-summer, it is necessary to transport them overland, to Mount Juliet, a distance of thirty miles. From thence the navigation is good, at all seasons, to St. Louis, a distance of four hundred miles."

(Mr. Judson F. Lee continuing):

Schoolcraft's statement here is that at mid-summer it is necessary to transport the goods overland to Mount Juliet, a distance of over 30 miles. This would have to be taken into consideration with other statements he made; examining that itself, it would show that at mid-summer overland transportation was necessary to Mount Joliet. And that during the spring and autumnal freshets no portage at all was necessary.

BENTON'S WABASH TRADE ROUTE.

The Witness (reading):

"The earliest expeditions from the French settlements on the St. Lawrence to the upper lakes followed the course of the Ottawa river rather than the upper St. Lawrence. Successive expeditions pushed the route farther west until under the leadership of such intrepid explorers as Jean Nicollett, Allouez, and Marquette there was developed about the middle of the seventeenth century what may be regarded as a westward highway for the French, continuous from the settlements on the lower St. Lawrence to the Mississippi valley. The voyagers' canoes followed the Ottawa river from Montreal, then by portage to Lake Nipissing, and to Georgian Bay, an eastern arm of Lake Huron, and thence by the northern lakes to Green Bay, the Fox, and by portage to the Wisconsin and Mississippi rivers. It was the most natural route because in every way it was the line of least resistance. It avoided the near approaches to the Iroquois Indian limits and led directly to the numerous Indian haunts around the greater lakes. As the objective point for the westward expeditions was gradually moved farther south

in the Mississippi basin, shorter routes across the territory, later known as the Old Northwest, were used. The Wisconsin portage soon yielded in point of frequency of use to those at the south end of Lake Michigan. The route up the Illinois river and by portage into the Chicago river and Lake Michigan was followed by Joliet and Marquette on their return from the discovery of the Mississippi. A few years later La Salle followed the coast of Lake Michigan to the St. Joseph river and up that stream, thence by a portage to the Kankakee, and so again to the usual destination—points on the Illinois

and the Mississippi.

About this time, in the course of the evolution of new routes leading to the Mississippi, occurred the first use of the Wabash river by white explorers. This stream was occasionally reached in the earliest period by leaving Lake Michigan on the St. Joseph river and then by a short portage to the headwaters of a northern branch of the Wabash, but the more important way to reach it was by the 'Miami river of Lake Erie' and a short port-Of the five great portage routes this was the last one to come into general use by the whites. It proved to be the shortest route connecting the lower French posts on the Mississippi with those on the St. Lawrence and has been quite happily called the Indian Appian way. It was a common highway for the various Indian tribes of The French routes were in almost all the Northwest. cases the watercourses, portage paths, or overland trails in earlier use by the Indians, who now became the guides. The portage from French creek to the Allegheny was used by La Salle, but its importance dates from a much later period, when it came to connect strategic points on the English frontier. In the race with the English for the occupation of the interior, the French gradually drew the cordon tighter. The paramount task for them was to keep in ready and rapid communication with one another and with outlying posts their two commercial and political centers, Quebec and New Orleans." *

CANAL COMMISSIONER'S REPORT OF 1825.

Whereupon the witness (Judson F. Lee) read as directed by counsel for complainant from the Commissioner's Report of 1825:

"A portion of the commissioners, therefore, in the fall

of 1823, accompanied by Col. Justus Post, whom they had engaged as their engineer, explored and examined the country from the rapids of the Illinois river with the streams emptying into the same, to Lake Michigan; and the country bordering on the Chicago river and Kalimick, which streams also empty into Lake Micnigan. The commissioners returned by water in canoes, examining the bed of the rivers, particularly the depth of water, and the height of the river banks. They also ascended the Chicago river, or arm of Lake Michigan, having its confluence with that lake on the west side, about 35 miles below the head of it, to the head of the river, 5 miles. From this point there is a portage of 7 miles to the river Desplaines. They then descended the Desplaines 50 or 60 miles to its mouth; where uniting with the Kan-kakee, a considerable river from the southeast, its source being in the country with those of the Wabash and Saint Joseph, the river Illinois is formed; thence down this river to its confluence with the Mississippi, 350 miles; thence down the latter, 18 miles, to Alton, the place from whence they had departed.

It is a source of much satisfaction for the Commissioners to be enabled to state, that the result of this examination eventuated in the conviction, that from the mouth of the Illinois river, to the Little Vermillion, a handsome stream 12 or 15 feet wide, discharging its waters into the Illinois river on the west side, and about 4 miles below the rapids of the Illinois, there is not the least obstruction to the navigation, excepting in two or three places below Spoon river, in extremely low states of water, where small sandbars show themselves, but

which, however can be easily removed." * * *

EXTRACTS FROM SMITH'S LIFE AND TIMES OF LEWIS CASS— Pages 185-188.

(Judson F. Lee continuing):

I have read the passages in Smith, Life and Times of Louis Cass, to which you have directed my attention, which have

been read as follows, page 185:

"At that time, the communication between Green Bay and Prairie du Chien, upon the Mississippi river, where these events were passing, was by water up the Fox river about two hundred miles to the portage, thence across to the Wisconsin and down that stream to the Missis-

sippi, which it enters three or four miles below Prairie du Chien. General Cass embarked in a birch canoe with fifteen paddles to visit the scene of difficulty, and to take such measures for the protection of the people and for restraining the Indians as might be found necessary."

(Page 188):

"From St. Louis, General Cass ascended the Illinois in his canoe and passed into Lake Michigan, by the water

communication, without leaving it." * *

(Page 188):

"At the head of the Desplaines, a branch of the Illinois which approaches near Chicago, is a shallow lake, appropriately named Mud Lake. The party entered it towards evening, and it soon became so dark that they could not discern the bank. The lake was covered with broad leaves of a kind of a lily, favorable haunts of disgusting looking water snakes. A birch canoe cannot touch the shore without danger of having a hole broken through its slight material. It is brought near the land, and there retained while the passengers disembark, and this is effected by their being carried ashore upon the backs of the voyageurs. And in the same manner is the freight disposed of. The canoe is then taken from the water and carried by the men upon the land. Finding they could not get to shore safely, the party spent the night upon that slimy sheet of water. Eighteen men in a small canoe, on a hot summer night, with the poles stuck into the mud across the canoe to steady it, accompanied with the most intense rain and with the most intense thunder and lightning,-such are the reminiscences which belong to that memorial night. And he who was not there, or has never been in such a place, if such another place there is, has little conception of what a formidable enemy a mosquito can be. During that long night,-long in suffering, though short in the calendar, for it was in the month of July,-the venomous attacks were beyond the power of description. As soon as the dawn of day enabled the party to discern the surrounding objects, the anchor poles were taken from the mud, and the voyage was resumed. A small branch of the Chicago creek takes its rise close to this Mud Lake, and the whole region being flat and marshy, when the waters are high this creek flows back into the lake, and thus a communication was formed by which boats passed from the Des Plaines, which runs through the lake, to the Chicago creek, and

of course to Lake Michigan. This channel of communication, though almost shut up by the rank water vegetation, was found in the morning, and the travelers entered it, and as the descent to Lake Michigan is rapid and the distance but a few miles, that space was soon passed over, and the canoe rested upon the broad bosom of that great lake. The magnificent city which occupies the junction of the Chicago creek and the lake, and of miles around, had then no existence. The white man was not there with the power and the desire to change everything around him. There were no troops, and but few families, and these were connected with the Indian They were of course exposed at all times to the sudden hostility of the Indians. As the canoe approached their cabins at the mouth of the creek, the voyageurs commenced their songs, and these were heard by the traders and at first mistaken for the shouts of the Indians. Knowing that the times were dangerous, they were at first in great fear, being entirely destitute of means of resistance, but they were soon and happily reassured by the sight of our flag and by the arrival of the canoe, and it was with demonstrations of the liveliest joy that they received General Cass upon the bank." *

Judson F. Lee (continuing reading from Vol. II Illinois Historical Collections, Virginia Series No. 1, known as Ca-

hokia Records, page exxiii):

"Affairs were further complicated by the presence of British merchants who had rushed into the region to capture the Indian trade. The Michillimackinac company, which had a store at Cahokia, was particularly conspicuous in this competition. The British were able to undersell the inhabitants in their commerce with the Indian and, since this deprived the villagers of a trade which they thought rightfully belonged to them, it was the cause of several complaints. All the British who appeared in the west were not simply traders. The British Government, which looked with covetous eyes on these rich lands, sent agents into all parts to report on the disposition of the people. Some of these, although not authorized by their government, openly urged the French people to unite with England, an issue out of their troubles which would not have been altogether unacceptable to the Illinoisans." * * *

CAHOKIA RECORD EDITOR'S PREFACE BY PROF. C. W. ALVORD, p. exlvii.

"We have seen that the Kaskaskians complained of the establishment of the Michillimackinac company at Cahokia. From the year 1773 many British merchants found their way to the Illinois and established stores in the village. Among the names which occur are J. B. Perrault, representing Marchiosseaux of Montreal, James Grant, Myers, Tabeau, Bullion, William Arundel, John Askins, and others. These merchants practically monopolized the fur trade of Illinois; but the Cahokians, finding that they interfered with the indian trade as well, were strong enough to make regulations to protect their own interests and gave a limited monopoly of that trade to one of the citizens of the village and prohibited all sale of liquor to the savages by others. When the indian outrages reached their climax in the year 1789 and Kaskaskians were begging the military officer at Vincennes to send troops for their defense, the Court of Cahokia still further regulated intercourse with the Indians and forbade all sale of liquor by any one."

Cahokia Records, p. 509, Power of Attorney, John Askins to Hugh Heward.

"Today the 24th of April, 1787, there appeared at the office of the Jurisdiction of Cahokia, in the Illinois, M. Hugh Heward bearer of the following documents and he has required the registry thereof, and has transcribed them in the present register himself, since the clerk does not understand the English language, as follows:

1st piece.

Know all men by these presents that I, John Askins of Detroit, merchant, have made, ordained, constituted and appointed and by these presents do make, ordain, constitute and appoint and in my place and stead, put and depute Mr. Hugh Heward, of Detroit, aforesaid, my true and lawful attorney for me, and in my name and for my use to ask, demand, recover, and receive of and from any person or persons indebted to me or any of my former co-partners; giving and granting to my said attorney my sole and full power and authority to take, pursue and follow such legal courses for the recovery, receiving and obtaining of the same as I myself might or could do,

were I personally present; and upon receipt of the same acquittances and other sufficient discharges for me and in my name to sign, seal and deliver; as also one or more substitute or appoint & again at his pleasure to revoke & further to do & perform & execute for me & in my name all singular Thing or Things which shall or may be necessary touching and concerning the premises as fully & entirely as I the said John Askins ought or could do in & about the same or as if more especial authority was required than is herein given—ratifying allowing & confirming whatever my said attorney shall lawfully do or cause to be done in & about the Premises by virtue of these presents.

In witness whereof I have hereunto set my Hand & Seal the fifteenth Day of November in the year One Thousand

Seven Hundred & Eighty Six.

Signed Sealed and Delivered in the presence of
John McCaslan, Witness
WILLIAM PARK
HUGH HEWARD.

That is followed by other powers of attorney; from John Askin, Geo. Leith, and Angus Mackintosh, of Detroit, and directors of Miamis Company, and Hugh Heward, of Detroit."

CAHORIA RECORDS, PAGE 523, POWER OF ATTORNEY TO WM. KAY.

"Know all men by these presents that we, Edw. Wm. Gray, Esq., Wm. Goodall, John Lilly, Peter Bouthiellier, and Robert Cruickshanks, merchants, executors of the last will and testament of Wm. Kay, late of Montreal, in the District of Montreal, in the Province of Quebec, merchant deceased, have made, ordained, authorized, constituted and appointed and by these presents do make, ordain, authorize, constitute and appoint Josiah Bleakley. late of Michillimackinac, but now of Montreal aforesaid. merchant, are true and lawful attorney, for us and in our name or (otherwise) and to and for our use, as executors as aforesaid, to ask, demand, sue for, recover and receive of and from, all and every person or persons whatsoever whom it doth, shall or may concern, and particularly of and from David McCrae, David McCrae & Co., Pierre Antoine Tabeau, Jean Baptiste Morelle; Jas. Aaron Holt and Chas. Gratoit at Michillimackinac or

elsewhere in the upper country, all such sum and sums of money, debts, dues and demands whatsoever, as are due, owing, payable or belonging to the said Wm. Kay at the time of his decease and now are or hereafter may become due, owing, payable, or belonging to as the executives of his said last will and testament, for or by reason of any cause, matter or thing whatsoever, and to compound and agree to take less than the whole for all or any of the debts or Demands aforesaid, where the whole in all appearance cannot be got; AND upon payment, recovery or receipt thereof or of any part or parts thereof, Acquittances or other Good and sufficient discharges in the Law for the same, for us and in our names as Executors as aforesaid, accordingly to make, Seal and deliver and Generally to do, transact, manage and perform all other matters and things anywise relating to the premises in such manner as to our said attorney shall appear most advisable and Expedient as fully, amply and effectually in all respect as if the most special powers were to our Said Attorney for the purposes aforesaid by us given, or as we ourselves might or could do personally; AND an Attorney or Attornies under him for the purposes aforesaid, with the like or more limited powers, to make and at his pleasure to revoke.

HEREBY allowing, ratifying and confirming all and whatsoever our said Attorney, or his Substitute or Substitutes shall Lawfully do or cause to be done in or about the Premises by Virtue of these Presents. IN WITNESS whereof we have hereunto sett our hands & Seals the twenty-fifth day of April in the year of our Lord, One

Thousand Seven Hundred & Eighty-eight.

Signed, Seal'd and deliver'd

in the presence of
JN. BOUTHIELLER
SAM'L GENARD.

EDWD. WM. GRAY	(L, S.)
W. GOODALL JOHN LILLY	. 46
P. BOUTHIELLER R. CRUICKSHANK	44

This registry was made on the requisition of M. Charles Gratoit and conforms to the original and was transcribed by me, Jean Dumoulin, merchant, in default of a knowledge of the English Language by me, notary at Cahokia, October 28th, 1788.

> CH. GRATOIT, JEAN DUMOULIN, JOSIAH BLEAKLEY."

(Judson F. Lee continuing):

I notice that this was registered in Cahokia same as other

powers of attorney (reading):

"This registry was made on the requisition of M. Charles Gratoit and conforms to the original and was transcribed by me."

PETITION OF LA CROIX IN REGARD TO TRADE, OCTOBER 29, 1785,

(Judson F. Lee continuing):

Referring to pages 575 and 577 of same volume, petition of La Croix in regard to trade, I will read into record:

"Petition of La Croix in Regard to Trade, October

29, 1785.

To M. M. The Magistrates and the Honorable Court of the District of Cahokia. Sirs:-

Jean Bte. La Croix has the honor to set forth to you that, for the public good, the Court granted him on the 8th of March, 1782, permission to trade with the savages in this village under the conditions declared in the decree of the said Court, rendered the said day, March 8, 1782. The said M. La Croix has not been troubled up to the present in his trading; but now he is in a position very prejudicial to the public and to the petitioner and which tends to cause the citizens to perish from hunger, especially at a time of such great calamity as we

find ourselves in at present.

The alien merchants of Michillimackinac, gentlemen are here and, far from contenting themselves with the asylum which we give them to sell their merchandise to the French, they are trading with the savages who come to this village for all goods which the said savages bring and are taking from us in this way the means of making a living, since they overcharge us for these same commodities of trade at exorbitant prices; and to the detriment of the people they are making hords of the goods in order to transport them out of the place or to sell them at prices most burdensome to the public. Since these merchants have no right of trade in this village and since.

if we have some goods to trade with the Indians (this) advantage should belong to us and not to strangers; and since we suffer them here for convenience, after having been sent away from the Spanish bank, it is not just in us to permit these traders to carry off before our eyes what Providence offers us through the savages. But these traders are trading before our eyes and up to our very doors not only in merchandise but also in what is more pernicious, drink, and are favoring the savages at a time when one cannot be too careful. In order to avoid the evils which may result therefrom, I pray, gentlemen, that you have the goodness to continue me in my trading right and that all alien merchants for the future be forbidden to participate therein in this village or to trade in anything with the savages who come here, on pain of a fine, such as it shall please you to fix, and of confiscation of that for which they shall have traded; and in return the petitioner offers to conform to the conditions of the decree of the Court of the said 8th of March, 1782, so that this branch of commerce be preserved for us in our village (and not pass) to aliens; and this is my conclusion. At Cahokia October 29, 1785.

J. B. H. LA CROIX."

Kaskaskia Record, Page 172-Letter of Thomas Bentley to A. S. DE PEYSTER, Aug. 12, 1780.

(Judson F. Lee continuing):

I have volume 5 of Illinois Historical Collections and have turned to page 172 and 173, letters of Thomas Bentley (reading):

"Thomas Bentley to A. S. De Peyster, August 12th,

(B. M. 21845, f. 42-A. L. S.) 1780.

Ouyah the 12th August 1780.

Sir:

I beg leave to refer you to what I have already wrote you on the subject of Mr. Dejean. I beg the favour of you after perusing the enclosed to address & forward to General Haldimand. As I wish to remit to Canada as well as to draw off from this Country I propose sending boats up this river for Detroit as well as the Illinois River for Macinac next Spring. I could wish for that purpose if it does not clash with the Service that the Savages might be requested not to molest any Boat going up those Rivers for the purpose of carrying Remittance which I hope & doubt not but you will think reasonable. If the General or yourself should do me the honor to write me wish you would address me in a fictitious name for fear of accidents & send it by a person of confidence to be delivered only to myself. It is reported here that Canada is attacked by a French Fleet. It is likely to fall (which I hope will never be the case) beg of you to destroy these letters. I have the Mortification to inform you that Rochablave's malice has ruined me (irretrievably I fear) although my misfortunes originated with you yet I do not blame you. If you will be pleased to put me in a way of recovering myself at Detroit which you now have in your power to do, I will repair to you on your sending me proper Guides, but it must be in the Mercantile Line as I could not pay my debts & recover my lost Fortune by any other means. I have the Honor to be with real respect,

Sir, Your very obt hble Servt.
T. Bentley."

(Judson F. Lee continuing):

I know who Thomas Bentley was in a general way; he was a trader that had headquarters at Cahokia, traded at New Orleans, Montreal, Detroit and Michillimackinac, I believe; maybe other places. I think traded at Montreal; did at number of those places at least.

I read into record at page 369 of Volume 5 of Illinois Historical Collections: "Memorial of Francois Carbonneaux to

Congress, December 8, 1784.

THE MEMORIAL OF FRANCOIS CARBONNEAUX TO CONGRESS—DEC. 8, 1784.

"To the Horble: The United States of America in Congress assembled. The Memorial of Francois Carbonneaux of the Illinois Country, Agent for the Inhabitants

thereof humbly showeth:

That the said Inhabitants to the Number of four hundred Families exclusive of a like Number at Post Vincent, labour under the greatest Inconveniences for want of Order and good Government. That many ill disposed Persons have taken Refuge in their Country—That Population is daily encreasing—That their Property is invaded and arrested from them by the Hands of daring Intruders and that Violences are frequently committed

in various Ways, against their Persons and against the Persons and Properties of the Natives. Your Memorialist doth therefore in behalf of the Inhabitants aforesaid, humbly pray, that Congress will be pleased to take their distressed Case into Consideration, and either immediately establish some Form of Government among them, and appoint Officers to execute the same, or that they will nominate Commissioners to repair to the Illinois, to inquire into their Situation, and to consult with the Inhabitants thereon; and do and execute such Matters and Things as they shall find necessary, until some regular government can be established.

Your Memorialist conceives that it is in the Power of Congress by such a Measure, not only to restore Trangality among the Inhabitants of an extensive and fertile Country but to give Peace to those of the Frontiers of Virginia, and to establish, a valuable Commerce not only with the Natives, but with new Spain which is now wholly

carried on by British Subjects from Canada.

Trenton, December 8, 1784.

CARBONNEAUX."

Kaskaskia Records, Page 410. Letter of Jos. Parker to President St. Clair, Pres. of Continental Congress. Dated Oct. 2nd, 1787.

(Mr. Judson F. Lee (continuing):

Turning to pages 410 and 411 of letter of Jos. Parker to President St. Clair, "Jos. Parker to President St. Clair, Octo-

ber 2nd, 1787," I read last paragraph (reading):

"The inhabitants also complain of the traders from Michilimackinac and Detroit, that they should be suffered to remain in their villages, and engross all the fur trade and country belonging to the United States to the great injury of American subjects. The inhabitants are of opinion that nothing but a government will check their practices of setting the savages upon them.

There is such a considerable trade carried on in the Illinois, that a sufficient revenue might be raised by laying a duty upon the goods carried into that country and upon the fur carried out. The traders in St. Louis and St. Genevieve on the other side of the Mississippi have not less than an hundred traders who are supplied with goods annually from Michilimackinac and Detroit and sent down to Kaskaskia and Cahokia and the Spaniards

come over and purchase them. Each trader purchases on an average from thirty to forty thousand livres annually which is \$6000.00. The traders of St. Louis and St. Genevieve have often told me that if the Americans would supply them with goods at Kaskaskia & Cahokia, they would give them the preference and allow them the 125 pr ct advance on the Sterling cost. You will easily perceive the revenue that might be raised annually in that new country.

I am, sir, yr hble servt.

Jos. PARKER."

(Mr. Judson F. Lee continuing):

Don't know whether Parker was sent out pursuant to Carbonneaux Memorial. Memorial is dated Dec. 8th, 1784; Parker's letter is dated 1787. Having read record before remember name Parker being connected with incident in Kaskaskia of driving out John Dodge. Find note here speaking of hostility of two men. Don't know full details of Parker or how long at that post; at Kaskaskia think very short time. Think St. Clair was President of Congress.

Kaskaskia Records, Page 381. Petition to Congress by Pierre Langlois.

I turn to page 381 and 382 petition of Pierre Langlois, bottom page 381 (reading):

"Pierre Langlois

Notary and Clerk.

Kaskaskia, county of the Illinois, this second day of June, of the year of our Lord one thousand seven hun-

dred and eighty-six.

We, the undersigned pray Congress to take notice of the country of the Illinois and to establish immediately the government for the protection and defense of the inhabitants and their property, for we believe (that) the fertility of the land and the great advantage to be derived by Commerce (will attract) a great immigration to the advantage of the country. We think that this is not a small object for Congress. It is for this reason that we pray for a system of government to protect us, to strengthen our hand and to maintain our rights, not only against the Indians, but rather against Michilimackinac and a company of the subjects of Great Britain who are getting possession of the commerce from the good subjects of the states. They have established at Ca-

hokia a Village near us a trading post which causes great harm and detriment to the good subjects of the states. They have destroyed the establishment of the law which the inhabitants had made among themselves. We suffer

a great loss in the recovery of our just debts.

We, therefore, again pray Congress not to abandon us any longer; but to send and grant us laws without delay, for the subjects of Great Britain threaten to take us under their laws. Likewise a few persons upholding the subjects of Great Britain have installed themselves as commanders to such a point as to take subjects of the states and transport them to the Spanish shore and have them imprisoned, to the disgrace of the establishment of the government of the states. The men who have assumed command are M. M. Nicholas Lachanse and John Dodge.

PIERRE LANGLOIS, Notary and Clerk."

(Judson F. Lee continuing): From my knowledge and recollection of passage in Vol. 2 of Illinois Historical Collections, page CXXXII, "The long expected reply from Congress was brought to Kaskaskia by Joseph Parker in January, 1787. The people were eager to learn its contents, and sent in haste to Barbau at Prairie du Rocher that he might come and open it," and of Perrault's statements, Heward's Governor St. Clair's statements, letter of Governor Cass to Kinzie, all in evidence, should think there was an indication that there was some little commerce, during period from 1782 to about 1817, that went by way of St. Louis, Cahokia and Kaskaskia and Canada? There was some commerce passing know just how much. between Canada and territory in vicinity of Cahokia, Kaskaskia and St. Louis. Think there are evidences of that, as I have read over the letters in Kaskaskia records. I find a number of traders who were connected with Canadian towns, a number of references that are in the book, that I could not refer to at present, however, indicate that some of that trade went by way of Detroit and other places.

Trip of Galloway and Family Down the Desplaines River in 1827.

Mr. MILO M. QUAIF, called as a witness for the defendant in the above mentioned case, testified as follows:

I have used Blanchard's History. Historians need to be on their guard in my opinion in using it. Have not made a critical study of Blanchard for this case, except in a general way. Blanchard lived here in Chicago, about a generation ago and undertook to write a history of Chicago and to some extent the Northwest generally.

Blanchard's History, Chicago, Blanchard & Co., 1898, page

503 (reading):

"This young Miss is now, 1880, Mrs. Archibald Clybourn, residing on Elston avenue, Chicago; and to her is the writer indebted for the preceeding facts relating to her father. In the spring following their residence at Lee's Place 1827, her father, Mr. Galloway, moved with his family to the home he had purchased the year before. His transportation to the place was effected by means of a large boat fashioned on the dug-out plan, which he made himself from a black walnut tree, on the banks of the Chicago river. Taking advantage, of the usual spring freshets, he navigated this vessel, freighted with his family and all his valuables, through Mud Lake and down the Des Plaines and Illinois rivers, to his home. The place was then called the Grand Rapids of the Illinois. Here Mr. and Mrs. Galloway spent the remainder of their days, highly esteemed by all who knew them. Mrs. Galloway died in 1830, and Mr. Galloway survived till 1864, when he died, and many of the present inhabitants of Chicago will doubtless remember reading the becoming obituary notices which the Chicago papers gave of him at the time."

LETTER OF GORDON S. HUBBARD TO RUFUS BLANCHARD, OCT. 13, 1880.

Mr. Milo M. Quaif (continuing):

My attention is directed to a letter from G. S. Hubbard to Rufus Blanchard, dated Chicago, October 13, 1880, in Blanchard's "Discovery and Conquests of the Northwest. 1881." I know this work in a general way. In the sense that

historians use all printed works that happen to be of interest. I would say they would use this. I am not commending Blanchard.

The letter is as follows:

"Chicago Oct. 13, 1880.

Rufus Blanchard:

My Dear Sir:-Your favor of the 11th is at hand, and I most cheerfully give you what information I possess on

the subject matter of your note.

Prior to 1800 the north branch of the Chicago river was called by the Indian traders and voyagers 'River Guarie' and the south branch 'Portage River'. On the west side of the north branch a man by the name of Guarie had a trading house, situated on the bank of the river about where Fulton street now is. This house was enclosed by pickets. He located there prior to 1778. This tradition I received from Messrs. Antoine Deschamps and Antoine Beson, who, from about 1778, had passed from Lake Michigan to the Illinois river yearly; they were old This tradition was men when I first knew them in 1818. corroborated by other old voyagers. The evidences of this trading house were pointed out to me by Mr. Deschamps; the corn hills adjoining were distinctly traceable, though grown over with grass.

I am of the opinion that these branches retained their names until about the time of the location of the first Fort Dearborn, and were afterwards known as the north and

south branches.

My impression is that Elijah Wentworth opened his tavern on the West Side, near the present west Kinzie street in 1830 at what was then called the Forks. About this date Samuel Miller bought a small log cabin on the opposite side of the river from Wentworth's and south of the present Kinzie street bridge to which he added a two-story log building, finishing the outside with split clapboards. These two public houses were the first Chicago could boast of. Miller by his influence and enterprise, erected a bridge built wholly of logs, across the north branch, just north of his tavern. He and Wentworth being competitors for public favor, the Forks House getting the most patronage, Jos. and Robert Kinzie built stores there, and here resorted some of the officers of the Fort daily, for social intercourse and 'drinks' at Wentworth's bar. Wolves were in those days quite numerous; one had the audacity to enter in the daytime Wentworth's meat house, and was by him killed. His house had for a sign a tall sapling topped off just above a prominent branch; it extended some distance above the top of the roof, and was a conspicuous notice, to be seen from the prairie, and surroundings, that 'here was food for man and beast'; it lacked however something to hang to the branch projection, to give it character; how to obtain a proper emblem, puzzled the good landlord, as there was no carpenter, or paint shop, or citizen artist; a happy thought struck him, that Lieutenant Allen might condescend to supply the deficiency, if properly approached; this was effected through a mutual friend. The boards of a dry goods box were obtained, from which was put in shape, under the superintendence of Lieut, James Allen. a well proportioned sign, the Indian Agency Blacksmith putting to it hinges, when Lieut. Allen took it in hand again, producing and presenting to Wentworth the picture of the slethy wolf, which was to serve not only an attractive painting, but a memorial of the landlord's valor in killing alone and unaided, of a ferocious wolf. Officers and citizens received invitations to be present at the hanging of the sign; the day and hour arriving found assembled a majority of the people; the sign was brought forth, duly veiled with a blanket, was attached to the branch of the pole, the veil removed, and it swung gracefully, and was greeted with hurrahs from those present; in turn something else greeted the hoarse throats of friends. Thus was produced and baptized the name of 'Wolf Point.'

Besides Wolf Point was a place called Hard Scrabble,

of early historic interest.

Mrs. John H. Kinzie, in her book, 'Wan-bun,' correctly describes the location as 'Lee's Place,' Mack & Conant, extensive merchants at Detroit, in the Indian trade, became the owners of this property about the year 1816. They sent Mr. John Craft with a large supply of Indian goods to take possession of it, and established a branch of their house there, the principal object being to sell goods to such traders as they could, residing throughout this country, without interfering with the interest of those traders who purchased goods from him.

Mr. Craft repaired the dilapidated building, adding thereto, and erecting others necessary for the convenience

of business. He, I think, named it 'Hard Scrabble'; whether he or someone else, it bore that name in 1818.

At the organization of the American Fur Company 1816, Mr. Astor's plan was to control the entire trade by absorbing other companies doing an Indian business. He succeeded in buying out the Southwest Company, whose headquarters were at Mackinaw, but failed in his

efforts to buy out Mack & Conant.

Mr. James Abbott, however, their agent at Detroit, succeeded in buying them out in 1820 or '21, and they withdrew from the Indian trade, transferring their Indian goods, posts and good will to the American Fur, who constituted Mr. Craft their agent here, he removing his quarters from 'Hard Scrabble' to the company's warehouse, located north of and adjoining the military burying ground. They enlarged it and built a log warehouse, besides; J. B. Beaubien, who had previously occupied it, removing to the 'Factor House' adjoining Fort Dearborn. Craft died in the fall of 1826, and Mr. John Kinzie succeeded him. Mr. Wm. W. Wallace (who was one of Astor's men on his expedition to Columbia River) took possession of Hard Scrabble after Mr. Craft left the place, and died there during the winter of 1827-8. From that time till the land title passed from the government, it was occupied by several families temporarily, among whom were the Lawton's for a short time, and James Galloway, the father of Mrs. Archibald Clybourne.

Yours truly. G. S. HUBBARD."

LETTERS OF JOHN EGAN TO GEO. ROCERS CLARK.

Mr. Milo M. Quaife (continuing):

My attention is called to 18 Wisconsin Historical Collections, pages 439-440, a letter from John Edgar to George

Rogers Clark, dated October 23, 1786, which is as follows:
"Sir—I Recd, yours by Express of the Eighteenth
Instant and Observe the Contents of your Letter and am very happy to find that you put Confidence in me. There is nothing that I would not do to Serve General Clark, & my Country.

And you may Depend on me that I will Execute your Order or any other Orders, that you may think proper to enfaire on me, to the last tittle that is in my power. The inhabitants of these Villages is very much disaffected to the United States, owing much to the Michilimackinac Company, which holds a large Trading House at Cahokia for the supply of the Savages.

If any thing tourn up in the Illenois of Consequence I

shall immediately give you intellegance by Express. I am Sir your most Obedt. & Humble Servt.

JOHN EDGAR.

N. B. This Country is totally lost if we have not Government established here soon, etc. etc., I was oblig'd to give St. Ange a horse as the one he brought give out.

Kaskaskies 23d. Oct. 1786.

George R. Clark Esqr. Post Vincent."

EXTRACT FROM SCHOOLCRAFT'S LEAD MINES OF MISSOURI, pp. 41, 161, 243, read in evidence at the hearing of said above mentioned cause by and on behalf of the Government before Hon. K. M. Landis, Judge.

Mr Corneau: Yes. Just at this moment it seemed to be a good place to put it in because chronologically it fits right in. It is entitled "A View of the Lead Mines of Missouri, including some observations on the Mineralogy, Geology, Geography, Antiquities, Soil, Climate, Population and productions of Missouri and Arkansas, and other sections of the western country. Accompanied by three engravings. By Henry R. Schoolcraft, Corresponding Member of the Lyceum of Natural History of New York. New York. Published by Charles Wiley and Company, No. 3, Wall Street, 1819."

Schoolcraft's knowledge and competency on such questions is very fully discussed in the record. Some of it we have read and more of it will be stated as we proceed. The particular excerpt to which I now wish to call attention, or excerpts, rather, appear first on page 41, at which point he is speaking of the ultimate benefit to be derived by connecting Lake Michigan with the Illinois River by artificial means, evi-

dently, and is as follows:

"The river Plein, the mean head fork of Illinois approaches so near the head of Chicago river, which enters Lake Michigan at Fort Dearborn, that a communication exists in high water. I conversed with a trader last summer at St. Louis, who had come through in the spring, and afterwards saw his boat lying at the wharf. It carried from 4 to 6 tons, and was built skiff fashion, with a

flat bottom. He represented the undertaking as easy of execution, not requiring an artificial cut of more than 2 miles, and this through an alluvial soil."

The next excerpt is at page 161. This seems to be a general description of rivers and mountains in the territory concerning which he was speaking. The excerpt is as follows:

"The Illinois is also a stream affording a great length of navigation, and lands of superior quality and has a natural connection with the great north western lakes, by which boats may, at certain seasons, uninterruptedly pass from Lake Superior, and the Lake of the Woods,"

The next excerpt is from page 243:

"The Illinois is navigable 300 miles, and when the communication between it and Lake Michigan between the Mississippi, and Lake Superior, and the Lake of the Woods-between the Missouri and the Columbia-between the Yellowstone and the Multnomah, shall be effected, communications not only pointed out, but almost completed by nature, what a chain of connected navigation shall we behold? and by looking upon the map, we shall find St. Louis the focus where all these streams are discharged, the point where all this vast commerce must centre, and where the wealth and the refinements flowing from these prolific sources, must pre-eminently crown her the queen of the west."

Mr. Cressy (on behalf of the Government):

I am now reading from the Life and Writings of DeWitt Clinton, by William W. Campbell, published at New York by Baker and Scribner, in 1849. This has been submitted to counsel for defendant and they have had a chance to check through it. That is the reason why it was omitted.

Reading from page 140 (reading):

"We visited the Adams, a brig of 150 tons and four guns, belonging to the United States, commanded by

Commodore Brevoort"-Mr. Scott (on behalf of the defendant in said above men-

tioned cause): Where was that?
Mr. Cressy: What?

Mr. Scott: Where was he when he visited this; where was

he att Mr. Cressy: At Buffalo, he is writing at Buffalo. I think that is correct, Mr. Scott; if it is not you may correct it, but that is as I remembered it when I read it over.

(Reading page 140:)

"We visited the Adams, a brig of 150 tons and four guns, belonging to the United States, commanded by Commodore Brevoort, who appears to be a worthy officer. This is the only vessel we have on the lakes, and she is employed in transporting military stores. She can make a voyage to Fort Dearborn, upwards of 1000 miles, on lake Michigan, and return, in two months. The British have two armed vessels on this lake, one pierced for sixteen, and the other for twelve guns, and a fort to the southwest of Black Rock, called Fort Erie and garrisoned by a Lieutenant and twenty men.

Commodore Brevoort says that vessels drawing seven feet water, can at some seasons go from Fort Dearborn or Chaquagy (Chicago), up a creek of that name, and to the Illinois River, whose waters in freshets meet, and go down the Mississippi; he thinks he can effect it in his brig, which draws but six feet when lightened. A brig of 150 tons, sailing from Black Rock to Hudson, would seem incredible."

Mr. Cressy: I think this diary bears a date here, doesn't it, Mr. Scott?

Mr. Scott: Yes, it does.

Mr. Cressy: It is August 5, 1810.

"Extract from Pamphlet by Ossian Guthrie in Regard to the OPERATION OF PUMPS AT BRIGEPORT."

Mr. J. W. Woerman (continuing): On page 27 Mr. Guthrie gives a table which gives the period in each year during which the Bridgeport pumps were operated from 1860 to 1867, inclusive, and certain other data in connection therewith, which said pages 27 and 28, were considered as read and copied into the record, and are as follows, to wit:

Economy
Abstract
Page 1045

"EXTRACTS FROM PAMPHLET BY OSSIAN GUTHRIE BY 105 AT BRIDGEPORT."

Page 1045		DR.	DOEL OILL.		
	Running time in min's.	Cubic ft.	Popula-	Cubic feet per min. per 100,000 inhb's.	Remarks
1860			109,000	11,009	
June 31 to July 31 Aug. 1-31 Sept. 3-26	9,171 4,891 3,011	12,000 8,257 14,000	109,000 109,000	7,575 12,844	
1861					
June 23 to Aug. 31	23,100	11,000	124,000	8,800	
1882					
May 28-31	2.810	18,000	138,000	13,000	
June 22-30		12,000	138,000	8,834	
July 1-19		13,400	138,000	9,700	
1863				0.480	
July 5-31	. 15,710	12,500	153,000	8,170	
Aug. 1-31	. 16,430	10,500	153,000	6,680	
Sept. 1-30 Oct. 1-15	10.915	10,000 te Sept.	153,000	6,500	
1864					
June 11-30 July 1-16 Aug. 11-31 Sept. 1-30 Oct. 1-31	13,995 15,395 Same as	10,800 10,000 10,600 August.	169,000 169,000 169,000	6,400 5,900 6,200 6,200 4,000	This year showed the first deposit of sludge in the canal.
1865					
May 29 to Oct. 2 inclusive	5,		290	934,000	Irregularly.
1866				= 000	After this date ir-
June 7-30	24,480	10,000	200,000	5,000	regular.
1867 June 19–30	15,840	12,340	225,000	5,500 or an ave'ge 5,041	needs of Chicago.
July 1 to Nov. 1	5 198,720	13,000	225,000	Ave'ge 5,500	

[&]quot;Extracts from Pamphlet by Ossian Guthrie in Regard to the Operation of Pumps at Brigeport."

"Sewage Dilution.

To the Joint Special Committee appointed to investigate in relation to the effect of Chicago Sewage upon the rivers through which it passes: Gentlemen :-

You will recollect that at your meeting of March 31, Mr. J. D. Paige, representing the delegation from Joliet, contended that no benefit would be derived from dilution. In reply to my question he said that no disagreeable effects were ever experienced until after the deepening of the canal in 1871, and in this position he seemed to be supported by the whole delegation, or at least was not contradicted by a single member. My object in questioning Mr. Paige was to lay the foundation for introducing the above table showing the operation of the Bridgeport pumping works from 1860 to 1867, inclusive.

The pumps were operated to the close of the year

1870.

This record shows, particularly that in 1867, for a period of five months almost the entire sewage of Chicago (the city then containing 225,000 inhabitants), was sent down the canal diluted by 5,500 cubic feet of water per minute for each 100,000 inhabitants, and passed Joliet unnoticed, as shown by her own delegation it had done. To a greater or less extent, Chicago sewage, it was also shown, had, since the opening of the canal in 1848, passed Joliet: much of this time, by reason of long delay in starting the pumps, the Chicago river was in as offensive a condition as it has ever been since. This evidence, with that of Mr. Paige undisputed, viz.: that no inconvenience was ever felt until after the deepening of the canal in 1871, seems conclusive that sewage may be so diluted as to be inoffensive to the senses. In addition to the degree of dilution shown above, the flow of the Desplaines river was then uninterrupted, and summer packing, which now contributes largely to the river dilution, was unknown.

O. GUTHRIE."

The following are extracts from G. P. Brown's book entitled Drainage Channel and Waterway:

Chapter I-Water Supplies of Large Cities.

Chicago is the only great city in the world that has easy access to an unlimited supply of pure water—not the chemically pure product of distillation, but that which is free from organic pollution. Water is suitable for domestic use when it does not contain matter which is itself poisonous, or which is food for disease producing bacteria. In its natural state,

the water of Lake Michigan contains no trace of such matter,

and in this sense is pure.

Not only does Chicago obtain unrivalled water from an exhaustless reservoir, but from one which lies at its very door. It needs to build no costly aqueducts, construct no artificial storage basins, and make no provision against drought. Nature has fairly lifted the cup to Chicago's lips. Lake Michigan has been one of the sources of the city's unrivalled prosperity. Good water flows through the arteries of a city as pure blood through the body, refreshing and sustaining it. wholesome water there can be no permanent aggregation of people. The growth of cities is limited by their ability to secure and maintain a suitable supply of water. The struggle for it is often so great as to excite pity. Vast sums of money are spent and useful lives sacrificed. Energies which should be used in developing commerce and manufacturers are wasted in a warefare with nature.

New York was compelled to go into the country forty miles and collect the waters of small streams into artificial lakes. These are more or less contaminated, and constant efforts are required to check the pollution. Dams, aqueducts and tunnels have cost the city nearly \$30,000,000, and still the system must be extended as the city grows. Plans have been adopted recently for the construction of a new dam which will collect the waters of a region 376 square miles in extent. This and its auxiliaries will cost \$5,000,000, and six years will be re-

quired for its completion.

Boston goes to Lake Cochituate for its water supply, a distance of twenty miles, and has paid more than \$10,000,000 for

storage reservoirs and a brick conduit.

Philadelphia is supplied mainly from the Schuykill River, whose waters are delecteriously affected by the sewage of towns, and the waste of factories. Three plans for an improved supply are now under consideration, any one of which

will cost not less than \$20,000,000.

London obtains about one-half the water it uses from the Thames above tidal limits, and the remainder from smaller streams and springs. At the present rate of increase in the population of the city it is estimated that, within thirty years, the amount required will exceed the supply of the entire Thames basin in times of drought. In the near future it will be necessary to provide increased storage capacity, or discover new sources of supply. Dr. Frankland says the water of the Thames and Lea is becoming more and more unfit for domestic use, on account of sewage pollution, notwithtsanding the most efficient means of filtration are employed at the reservoirs.

Paris derives its supply from the Seine, the Marne, the Ourcq canal, artesian wells and springs. Only that from the wells and springs is fit for domestic use and this is limited in amount. Expensive works have been required to conduct the water supply from the various sources to reservoirs on heights near the city. The main aqueduct is 110 miles in length and there are subsiding conduits 50 miles long.

Vienna goes to the Styrian Alps for water, a distance of 56 miles. Marseilles also depends upon the melting snows of the Alps, and the canal it constructed to the Durance was one of the boldest undertakings of modern times. This canal is carried through three chains of limestone mountains, which are penetrated by forty-five tunnels. It crosses many valleys by aqueducts, one of which, carrying 198,000 gallons per minute,

is 262 feet in height.

Manchester built seven impounding reservoirs, whose embankments are from 70 to 100 feet above the level of the valley in which they are constructed. The water with which they are filled is collected from the River Etherow and its tributaries, and is conveyed by an aqueduct 20 miles in length. The gross supply from the entire drainage ground will not exceed 40,000,000 gallons daily.

Versailles spent large sums of money and sacrificed many lives in an unsuccessful attempt to bring water from the River Eure, and the famous aqueduct bridge of Maintenon is the most magnificent structure of the kind in the world. Finally, the waters of the plateau between Versailles and Rambouillet were collected and led by channels 98 miles in length through

the city.

Constantinople brings its water through valleys and by aqueduct from the valley of Belgrade, a distance of 15 miles.

The difficulties encountered by Glasgow were almost insurmountable. The beautiful scenery about Loch Katrine, was made generally known by Sir Walter Scott, in "The Lady of the Lake." Public attention was directed to the clear waters of the Highland Lakes, and their use by the city was suggested. After years of discussion, an Act was passed for tapping Loch Katrine. Water is now conducted from this lake to the city by built tunnels, mined tunnels, aqueducts and iron pipes. In all, there are seventy tunnels, eight feet in diameter. One of these is 600 feet below the surface. There are

twenty-seven aqueducts built over rivers and ravines. Some are of masonry and some of iron. A reservoir with a capacity of 500,000,000 gallons was constructed 26 miles from Loch Katrine, and 7 or 8 miles from Glasgow. Into this the water is first discharged. After undergoing a filtering process, it is conveyed in pipes through the city. It has cost nearly \$9,000,000 to perfect the system.

SITUATION OF CHICAGO ON LAKE MICHIGAN.

Lake Michigan, from which Chicago derives its water, is the second in size in the group of the Great North American lakes. Its mean latitude is 44 degrees north. Its length is 320 miles, and maximum breadth 80 miles. Its greatest depth is 840 feet. Although its surface is 594 feet higher than the surface of the sea, at the bottom it is 246 feet below the surface of the sea. The area of Lake Michigan is 26,000 square miles, and its basin about 43,000 square miles, a total area of 69,000 square miles. The lake is supplied by rainfall and the small streams which empty into it on every side, and its outlet is through the Straits of Mackinaw into Lake Huron.

Chicago is located on the southwestern shore of Lake Michigan. Its original site was low and flat, only a few feet above the level of the lake. The Chicago river, with its two branches, separates the city into three divisions. This comparatively insignificant stream is the remnant of a great outlet from the lake to the westward, which once discharged into the Mississippi river. As the waters of the Great Lakes receded, a ridge of limestone rock, nearly parallel with the western shore of Lake Michigan, and 12 to 20 miles distant, rose above their surface and created the watershed separating the basins of the St. Lawrence and the Mississippi. The Chicago river then began to drain the ponds and the swamps which successively appeared on the eastern slope and turned its course toward Lake Michigan.

By artificial means the river has been made to turn backward much of the time since the city has had a population of 300,000 and has become an open sewer. Spring floods and heavy rains frequently counteract the work of pumps, and the sluggish current has been first to the east and then to the west. The so-called stream is usually a stagnant bayou. It has been the source of much annoyance and has endangered the health of the people. The city's first rude sewers, constructed of planks and even the open gutters along the streets,

emptied into the river; so have nearly all of the more systematic sewers ever since. There has never been sufficient means to lift the sewage above the ridge which separates the river from the outlet to the southwest and the result has been an almost constant discharge of sewage into the lake.

If the conditions could have remained as nature planned them, Chicago's water supply would never have been contaminated. When the city was small, the inhabitants were not troubled; a little sewage did not affect so large a body of water. As the city expanded, this method of sewage disposal became an evil, too great to be ignored. But the plan could not be easily changed, and the city has gone on ever since in a sort of blind fatuity, trying to convince itself the situation was not serious. Spasmodic efforts were made to cleanse the river when self deception was no longer possible. efforts have failed to secure permanent relief.

CHICAGO'S WATER SUPPLY SYSTEM.

Chicago obtained its first water supply from wells. These were dug in the sand which had been heaped up by the winds, or in the silt deposited by the receding waters of the lake. Acting as a great filter bed the sand might have kept the water free from pollution, had there not been an impermeable stratum of blue clay near the surface. In spite of serious contamination the wells were used for twenty years after Chicago was incorporated as a village, although they were not

the only source of water supply.

To understand how the wells became unfit for use, a reference to the geological structure of the region embracing Chicago is necessary. The underlying rock is Niagara limestone. Upon this rests the blue clay, whose average depth is about 100 feet. Lake Michigan formerly extended to the ridge already referred to as the watershed of the St. Lawrence and Mississippi basins. As the underlying rock comes to the surface at the ridge, so the clay stratum thins out at the rim. When the lake receded, sand banks, or dunes were formed across the basin, which extended from the bluffs at Winnetka southward twenty or thirty miles. Between these ridges of sand there were formed inland lakes or ponds in which a luxurious vegetation sprang up. From the resulting decay came the vegetable mold which lies on the surface in some places within the city limits. It is upon this bed of sand and vegetable mold with blue clay beneath that the city of Chicago stands. At no place was the original level more than twelve feet above the lake. It was the custom when Chicago was a village, as in small villages everywhere today, to dig both the well and the vault on the same lot. The wells were never more than twelve feet deep and usually six. The seepage from the vaults moving freely over the surface of the clay was naturally toward the wells. No health statistics were kept but there were epidemics which were believed to be expressions of divine wrath. Dr. A. S. Martin, an early resident of Chicago wrote to *The Sanitary News* in 1884:

"The water supply was taken from wells sunk on individual premises, or on vacant lots—sometimes in the streets. Dish-water, wash-water, and all fluid refuse from the kitchen, were generally thrown on the ground in back yards. In time, the water drawn from the wells began to taste,—a little brackish at first, then saltish, and finally it had a perceptible odor, which ultimately became

offensive. A well, at length, had the odorous characteristics of a privy vault. When it rained the water in well and privy vault rose accordingly; unless the prudent householder 'banked' the latter it often overflowed.

The disuse of wells brought into existence a new enterprise, that of hauling water from the lake and selling it. A hogshead mounted on an axle between two wheels and drawn by a horse was first used. The only opening was a hole at the top sufficiently large to admit a pail. The vehicle was backed into the lake until the water came conveniently near the top, when the hogshead was filled by the use of pails. The driver then proceeded up the street, mounted on a cross-piece in front of the hogshead, and served those who hailed him with water at a shilling per barrel. The use of the pail in emptying was finally superseded by a hose, tacked around a hole about four inches in diameter near the bottom. At length contracts were made and many families were supplied on certain days of each week, or every other week.

When Chicago became a city, water works were established just south of the south pier. Although primitive, they answered the purpose for which they were intended very well. I think the mains were originally of wood, and were tapped by lead pipes. At times they would fail, when the water carriers would have a harvest. As the system was extended, iron mains were laid along the principal streets. Various devices were tried; some

failed, others succeeded. On the whole, the people of

the Garden City made very little complaint."

Official action was taken on November 10, 1834, to supply the people of Chicago with water. The village council appropriated \$95.50 for digging a public well at the corner of Cass and Michigan streets. This well supplied only a small colony on the North side; persons living on the south side continued to draw water from their individual wells, or to buy it from the water purveyors. Water cart owners found their business a lucrative one, and a company was organized. Water was taken from the lake at the foot of Van Buren street, and sup-

plied by carts as late as 1846.

But the lake was often tempestuous and it was impossible to fill the carts. The resulting dissatisfaction and hardship among the inhabitants prepared the way for a pumping system. The Chicago Hydraulic Company was incorporated by special Act of Legislature on January 18, 1836. The disastrous panic of 1837 checked the company's plans, and work was not fairly begun until 1840. The company's charter permitted it to operate a mill. The combined mill and water works were located at the present intersection of Michigan avenue and Lake street, then directly on the lake shore. An inlet pipe was laid on a crib-work foundation and extended out into the lake about five hundred feet. The pipe was of cast iron, about fifteen inches in diameter, turned downward at the lake end five or six feet. At the shore end was a tank with a capacity of five or six hundred barrels, raised above the ground a few feet by a block foundation. This slight elevation created the only pressure in the distributing system. The works were equipped with a 25 horse power engine and pump to draw the water from the lake to the reservoir, and about two miles of rude wooden pipe were laid. The sections of the pipe were pine logs, bored out by hand and strapped with hoop iron. The mains were six inches in diameter and were laid in the alleys about three feet below the surface. Remnants of these pipes have been unearthed from time to time, the latest when the foundations were dug for the new Chamber of Commerce building in 1889.

This primitive system supplied only a limited portion of the South division with water. Notwithstanding its apparent advantages, it is said that at least four-fifths of the people living within the corporate limits obtained their water for domestic use from the river or by water carts from the lake. In a reminiscent lecture delivered in McCormick Hall, on Jan-

uary 23, 1876, Governor Bross said:

"In 1848, Lake and Water, and perhaps Randolph streets, and the cross streets between them east of the river, were supplied from logs. James H. Woodworth ran a grist mill on the north side of Lake street, near the lake, the engine for which also pumped the water into a wooden cistern that supplied the logs. Whenever the lake was rough the water was excessively muddy; but in this myself and family had no personal interest, for we lived outside the water supply. Wells were in most cases tabooed, for the water was bad, and we, in common with perhaps a majority of our fellow citizens, were forced to buy our water by the bucket or the barrel from water carts. This we did for six years."

The Hydraulic Company does not appear to have made money out of its venture, but it maintained an existence until February 15, 1851, when the Legislature, again by special Act, incorporated the Chicago City Hydraulic Company. The indifference of the people was shown at the spring election. Of the 4,445 voters, 513 cast their ballots against the acceptance of the privilege granted by the legislature, and 1,244 did not

vote on the question at all.

Dr. John H. Rauch, first secretary of the State Board of Health, says, in his Second Annual Report, that the effect of drinking well water was so marked during the prevalence of cholera in 1849 and 1850, compared with that of drinking lake water supplied to a few inhabitants by the Hydraulic Company, this was one of the reasons urged for the incorporation of the City Hydraulic Company. Concerning the contamination of the wells during the cholera epidemic, it was observed that nearly all who drank the water of a certain well on North La Salle street died. This attracted attention, and was supposed to be owing to the fact that the well received the drainage from privies in the neighborhood, and in this way infected those who drank the water. This was true. But Dr. Rauch discovered afterward that, in this neighborhood, the soil was stratified with thin layers of blue clay, which was impervious to water, and whenever these layers were penetrated by wells, they acted as drains for a great area, the remaining portion or the soil being composed of sand until the thick stratum of blue clay underlying the greater portion of the city was reached.

There was some dispute as to the right of the city to en-

croach upon the privileges of the old Hydraulic Company, and satisfactory terms could not be made with it until the year following the incorporation of the company. The city then began the construction of its own works, which were put in operation in February, 1854. This was the beginning of the present system. Authority over the works was vested in a Board of Water Commissioners. The first board consisted of John B. Turner, A. S. Sherman and H. G. Loomis. The pumping works were located on the lake shore at the foot of Chicago avenue. Already the discharge of sewage into the lake from the river had caused annoyance, and an alternative location for the pumping works at a considerable distance south of the river was suggested. In recommending the site chosen, Chief Engineer J. McAlpine said:

"It is very questionable whether the small quantity which is discharged from the river would affect the quality of the water in the lake at a point 1½ miles south. From the consideration which I have given the subject, I am of the opinion that there is no perceptible difference between the quality of the water in the lake above the pier and that at the place 1½ miles south of the river, on which

the estimates have been predicated."

The water was taken from an inlet basin on the lake shore, separated from the lake by a semi-circular break-water with an opening to the southeast, and distributed through three reservoirs, serving the three divisions of the city, situated, respectively, at La Salle and Adams street, Chicago avenue and Sedgwick street, and Morgan and Monroe streets. The first two were built in 1853, and the latter in 1854. Each held about two or three days' supply. The first iron distribution pipe was laid in Clark street in 1852, and was four inches in diameter. To keep the three reservoirs filled it was necessary to operate the pumps about twelve hours a day. The use of these reservoirs was discontinued after the completion of the West side tunnel in 1874.

In a sketch of the water supply system, written in 1876, Chief Engineer Chesbrough says that the increased growth of the city after the inauguration of the water works, and the introduction of sewerage, together with the establishment of the packing houses, distilleries, etc., so increased the quantity of filth discharged into the lake, that complaints began to be made of impurity and offensiveness in the supply from the pumping works. Governor Bross, in the address referred to on a preceding page, spoke of the new works, and added:

"But our troubles were by no means ended. The water was pumped from the lake shore the same as in the old works, and hence, in storms, it was excessively muddy. In the spring and early summer it was impossible to keep young fish out of the reservoir, and it was no uncommon thing to find the unwelcome fry sporting in one's washbowl, or dead and stuck in the faucets. Besides, they would find their way into the hot water reservoir, where they would get stewed up into a very nauseous fish chowder. The water at such times was not only the horror of all good housewives, but it was justly thought to be very unhealthy. Worse than all this, while at ordinary times there is a current on the lake shore south, and the water, though often muddy and sometimes fishy, was comparatively good; when the wind blew strongly from the south, often for several days, the current was changed and the water from the river, made from the sewage mixed with it into an abominably filthy soup, was pumped up and distributed through the pipes alike to the poorest street gamin and to the nabobs of the city."

In 1859, Mr. Chesbrough relates, one of the water commissioners, Mr. Edward Hamilton, proposed to sink a wrought iron pipe, five feet in diameter, one mile out into the lake, to obtain the supply from a point which could not be affected by the river. This plan was referred to the chief engineer of the Board of Sewerage Commissioners, Mr. Chesbrough himself, to be examined and reported upon, with the request "that he also take under consideration and report on the matter of erecting additional pumping works, in such locality as shall secure a supply of pure water." In his report Mr. Chesbrough discussed several plans, but made no specific recommendation. A tunnel was suggested, but it was thought best to defer action until there could be further expert examination of the water, in the hope that much of the complaint was

without foundation.

But the water continued to grow worse and became very offensive both to the taste and smell. The Board of Public Works, created in 1861, discussed the various plans proposed for relief and experimented with filters, which were soon found

inadequate.

THE FIRST TUNNEL.

Ground for the tunnel was broken on March 17, 1864. The plan of the work included a land shaft at the western extremity of the tunnel at the foot of Chicago avenue, and the lake shaft at the eastern extremity. The tunnel was to be two miles in length, extending in an east-northeasterly direction from the pumping works. The horizontal diameter of the tunnel was fixed at five feet, and the vertical at five feet and two inches. Mr. Chesbrough says this size was determined upon for two reasons: It was sufficient to deliver a supply for one million inhabitants at the rate of fifty gallons a day for each person, the average quantity used at that time; and experience in Europe had shown that, while it was possible to make small tunnels in the most troublesome ground, the attempt to make large ones had sometimes failed, and at others had been attended with enormous difficulties.

"Although there was every reason to expect easy work here, there was a possibility of meeting deposits of quick-sand, or other soft, wet material. In order to remove as far as practicable every doubt of the final success of the work, this small size was adopted, in the full conviction that whenever it should prove insufficient to supply the demand upon it, the population and wealth of the city would be abundantly able to construct another, and, if necessary, a larger one."

The tunnel was completed substantially as planned, and the last stone was formally laid on December 6, 1866. The contract price was \$315,139. The final settlement was for \$380,784.60 including \$27,420 for extras on the tunnel proper, and \$41,225.60, for extras on the shaft, crib and east and west connections. The exact length of the tunnel was 10,567 feet.

THE SECOND TUNNEL.

In 1874 a second tunnel, seven feet in diameter, was completed under the lake from the crib to the North Side station. In the same year this tunnel was extended, also seven feet in diameter, under the city to the new West Side pumping station at Ashland avenue and Twenty-second street. There are other tunnels to connect the Central and Fourteenth street pumping stations with the West Side tunnel. In 1887 a shore inlet tunnel, seven feet in diameter and 1,500 feet long, was extended under the lake opposite the North Side pumping

station, to be used when the supply at the two mile crib should be endangered by ice or otherwise. This tunnel was seldom used until the latter part of 1891. In November of that year a new tunnel, planned to be eight feet in diameter, but which was made double and six feet in diameter for a part of the distance, was completed. It extended out under the lake four miles from the foot of Peck court. It was opened in November, 1892, and gave the city an ample supply of wholesome water. The use of the shore inlet tunnel was then discontinued.

CHICAGO'S SEWERAGE SYSTEM.

No effort was made to provide Chicago with a system of sewerage until the year 1855. Previous to that time the city was drained by submerged wooden boxes on a few of the principal streets. These were constructed primarily, to supply water for use in extinguishing fires. They were found to be serviceable in carrying away surplus water from the streets, and were afterwards used to a limited extent for house drainage. As they were laid without system and were limited in capacity they were of little use except for surface drainage. In wet seasons they failed to carry away even the surface water.

As a result the city was scourged by epidemics for six years in succession. The death rate became higher than that of any other city in the country. In 1854, with cholera raging, nearly 5½ per cent. of the population died. For the six years beginning with 1849 and ending with 1854, the death rate was 48.92 per thousand. In self defense the city was compelled to consider the construction of an adequate sewerage system. bill was passed by the Legislature on February 4, 1855, creating a Board of Sewerage Commissioners to be appointed by the City Council. The first Board consisted of William B. Ogden, J. D. Webster, and Sylvester Lind, one from each division of the city. E. S. Chesbrough, then of Boston, was appointed chief engineer. The remainder of the first year was spent in making surveys and preparing plans, which were adopted in December. Work was begun on the sewers in the spring of 1856.

Summarized, the Act creating the commission made these provisions: (1) It shall be the duty of the commissioners to examine and consider all matters relating to the thorough, systematic and effectual drainage of the city of Chicago, not

only of surface water and filth, but also of the soil to a sufficient depth to secure dryness in cellars and an entire freedom from stagnant water, and in such manner as best to promote the healthfulness of the city. (2) It shall be the duty of the commissioners, before entering upon the construction of any sewer, to fix upon a plan or system of sewerage of such a nature that all subsequent sewers may be executed upon that

plan.

(3) It shall be the duty of the Board to prescribe the location, arrangement, form, material and construction of every private drain or sewer emptying into the public drains or sewers, and to determine the manner and plan of such connection. (4) It shall be the duty of the board to see that proper drains or sewers are constructed from every lot in the city, which, in their judgment, requires it, and that such private drains or sewers are made to communicate with public drains or sewers in a proper manner, and they shall have power to require such number of drains or sewers to be thus

constructed as they shall deem expedient.

Systematic sewerage in this country was unknown when Mr. Chesbrough was called upon to suggest the best method of complying with the law. Not only was the chief engineer unable to profit by the experience of other cities, but the local conditions were unfavorable. From a sketch written by Mr. W. H. Clarke, principal assistant engineer in 1877, it is learned that when the original surveys for the sewerage system were made the surface of the ground in the vicinity of the North and South branches of the Chicago River was only three or four feet above the surface of the lake. It rose irregularly eastward, until at Michigan and Rush streets it was from ten to twelve feet above the same level; to the westward it reached about the same level at Ashland avenue. This configuration made it necessary to raise the grade of the streets to keep the sewers underground. After considerable discussion it was decided to fill in to a level of ten feet above ordinary water on the streets adjacent to the river, raising them with an inclination sufficient to protect the sewers and to permit the construction of cellars seven to eight feet in height. A higher grade was recommended, but it was argued that there would be difficulty in securing sufficient earth to raise the streets to the minimum height decided upon. A few years later it was found that the surplus earth of the South division was sufficient not only to raise the grade of the streets but to fill up the entire lake basin between the Illinois

Central Railroad and Michigan avenue. For a number of years after the construction of the sewers began, some of them were partially above ground, and others entirely so, in what are now business districts of the city. In other localities where the ground was high enough to cover the sewers the grades of the street were fixed by cutting out abrupt irregularities. In places where the ground was too low to permit the construction of well-drained cellars the grade was established at such a height above the surface of the lake as to give not less than seven feet in height to the cellars if they were entirely below the surface of the ground, and at a greater height if the principal floor was elevated above the level of the street.

Soon after their organization the sewerage commissioners asked the public for plans and suggestions. Thirty-nine communications were received. Some of them according to Mr. Chesbrough, were very able and interesting papers. Although none of the plans proposed was adopted, there were many valuable suggestions. Mr. Chesbrough's report to the commissioners was made on December 26, 1855. The plan he proposed was adopted by the board on December 31. It provided for the discharge of the sewage mainly into the river, which the chief engineer argues, would deliver it well out into the lake. The general arrangement of the sewers placed mains in each of the alternate streets running to the river, or about eight hundred feet apart into which two-foot brick sub-main sewers in the streets running at right angles were to discharge. The main sewers were from three to six feet in diameter and built of brick, the walls being eight and one half inches thick.

The original plans provided for the sewerage of what now seems to have been a very small territory. Its southern limit in the South division was Taylor street. In the West division the boundary line ran north on Halsted street to Madison, west to Sangamon, north to Fulton and east to the river. In the North division the district was bounded by Franklin street on the west, Chicago avenue on the north and Rush street on the east. Considerable time elapsed before this limited territory was provided with sewers. Up to the close of 1857, two years after the inception of the work, mains had been built only on Michigan avenue, from Washington street to the river; on Madison street east from Halsted to the river; on Randolph street east from Sangamon to the river; on Clark street south from Chicago avenue to the river,

and on Rush street south from Huron to the river. This gave only one main to the South division; two to the West division; and two to the North division. There were sub-mains on Randolph and Washington streets, extending from the Michigan avenue sewer to the river. These have since been converted into main sewers from State street west, discharging into the river, while the portions east of State street still discharge into the Michigan avenue sewer.

Mr. Chesbrough foresaw the evils resulting from the discharge of sewage into the lake. It was impossible at that time to create an outlet to the southwest, but he appears to have believed that this would be the ultimate solution of the sewerage problem, and his plans were in harmony with it.

INVESTIGATION OF 1856.

In December, 1856, Mr. Chesbrough was instructed by the sewerage commissioners to

"proceed to Great Britain and the continent of Europe, for the purpose of examining the various methods of sewerage adopted there, and of taking such notes and drawings of the same as he may think necessary, and of examining into their operation, and into all matters connected with them, and which may, in his judgment, aid in the further prosecution and perfection of the sewerage

of the city of Chicago."

Mr. Chesbrough complied with the order, and made a thorough investigation of the sewerage systems of Liverpool, Manchester, Rugby, London, Amsterdam, Hamburg, Berlin, Paris, Worthington, Croydon, Leicester, Edinburgh and Glasgow. The results of his trip are given in a detailed report transmitted on March 25, 1858. No one of these great cities, he said, furnished an exact criterion by which to judge of the effect of discharging the sewage of Chicago into the river and its branches. Yet, their experience led him to fear that this city might yet conclude, as they had, that it would be necessary to keep the sewage out of the river. Chicago's plan was based upon the supposition, well founded, as has since been shown, that the natural state of the river during the summer months would require artificial aid to keep it in a healthy condition, and therefore provided for driving fresh water into the upper portion of the South branch from the lake. But the scheme for flushing the river was never carried out, and the idea was practically abandoned in 1860. The deep cut of the

Illinois and Michigan canal had been proposed, and the commissioners concluded that the construction of the canal from the lake to the South branch along Sixteenth street according to the original plan, would be unnecessary.

Mr. Chesbrough did not overlook the advantages of an out-

let to the southwest. He said:

"The through cut for a steamboat canal to the Illinois river, which the demands of commerce are calling more and more loudly for, if ever constructed, would give as perfect relief to Chicago as is proposed for London by the latest intercepting scheme; that is, it would furnish a constant and abundant stream from the lake flowing westwardly throughout the season of navigation, and consequently during the warm and sickly portions of the year."

POPULATION OF DISTRICT, 1892.

The following table, which shows the distribution of population in the Sanitary District, and particularly the fact that the waste from a population of 270,000 discharges at once into lake, was presented to the Trustees of the District in a report made by the joint Committee on Engineering and Finance on October 12, 1892:

"DISTRIBUTION OF POPULATION IN SANITARY DISTRICT.

North Branch above Fullerton Ave 28000 North Branch below Fullerton Ave 204000	1892 73000 345000
Total 232000 Main River) North Side 62000 and) South Side 72000 South Branch) West Side 279000	418000 86000 90000 416000
Total 413000 South Fork	592000 200000
Total tributary to River 725000 Lake Shore	1210000 185000
madia District 829000	1395000

Total in District The destination of the sewage of the entire population of the Sanitary District and adjacent townships is shown

in the following exhibit for 1892, the figures being	ng given
in round numbers. Chicago River	1,213,000
Lake Shore of Cook County (including the Calu-	
met)	22,000

CONDITION OF RIVER, 1861.

In 1861 the Board of Sewerage Commissioners went out of existence. Their duties, together with those of the Water Commissioners and of other departments, were transferred to the Board of Public Works, which was organized on May 6, 1861. In his first report to the new Board, on February 24, 1862, Chief Engineer Chesbrough called attention to the impurity of the river. "There have been several occasions during the last three years," he said, "when many persons thought they could perceive the effect of the river in the taste of the water, but not until the night of the 10th inst., and during several days since, did that effect become so striking as to convince all who have examined into it of its real nature. On the morning of the 10th the wind being from the south and westward, the lake fell to an unusually low point. This, of course, caused a very large amount of water to be discharged from the river into the lake, producing the well known disagreeable effect upon its taste and smell, so that it could be distinctly perceived along the shore, from a considerable distance south of the river to the cemetery on the north. Since the 10th the water has twice been free from this taste and smell, and twice it has become offensive. The taste thus given to the water supplied to the city is much more offensive than that caused by the fish, while it is utterly impossible by any means at the disposal of the Board to prevent it at present."

AGITATION FOR DEEPENING I. & M. CANAL.

Commercial and sanitary interests joined hands in the winter of 1864-5 and agreed upon measures for the deepening of the Illinois and Michigan canal. The river does not seem to have become more offensive than it had been during the previous two or three years, but it was apparent that the ultimate result would be most serious unless steps were soon taken to purify it. Public discussions were had as to the legislation which would best accomplish this object, and a joint committee was appointed by the City Council and Board of Trade to consider the matter. On the recommendation of this joint committee a commission was appointed by the City Council to continue the investigation. The commission consisted of Mayor F. C. Sherman, William Gooding, R. B. Mason, John Van Norwick, E. B. Talcott and E. S. Chesbrough.

In the meantime the question was agitated in the State Legislature, and an amendment to the charter of the city was secured which authorized the appointment of two additional members on the Board of Public Works, empowered to act with the other members of the Board, but only on matters relating to the cleansing of the Chicago river. The new members were William Gooding and Roswell B. Mason. The regular members at this time were John G. Gindele, president, Frederick Letz and Orrin J. Rose. Before the special commission made its report an Act was passed by the Legislature providing for the completion of the Illinois and Michigan canal upon the plan adopted by the state in 1836. This Act

was approved February 16, 1865.

The preamble recited the fact that it had been represented that the city of Chicago, in order to purify or cleanse the Chicago River, by drawing a sufficient quantity of water from Lake Michigan directly through it and through the summit division of the Illinois and Michigan canal, would advance a sufficient amount of funds to accomplish this desirable object; that the original plan of the canal was to cut down the summit so as to draw a supply of water for navigation directly from Lake Michigan, which plan was abandoned for the time after a large part of the work had been executed in consequence of the inability of the state to procure funds for its continuance, and that under the law the plan of the summit division was changed, the level being raised so as to require the principal supply of water through the Calumet feeder, subject to serious contingencies, and by pumping at Bridge-

port. Then followed the enactment which made these provisions:

1. To secure the completion of the summit division of the Illinois and Michigan canal, upon the original "deep cut" plan, with such modifications and change of line, if necessary, as will most effectually secure the thorough cleansing or purification of the Chicago River and facilitate the execution of the work, the city of Chicago, through its constituted authorities, may at once enter into an arrangement with the Board of Trustees of the canal with a view to the speedy accomplishment of the work.

2. The canal shall not be constructed of a less capacity than provided in the plan adopted by the Canal Commissioners in 1836, nor shall the work of deepening it be prosecuted so as materially to interfere with navigation. By consent of the Board of Trustees navigation may be opened later and closed earlier than usual in former years, but it shall never be dimin-

ished to a less time than six months.

3. It shall be lawful for the city of Chicago to enter upon and use any lands which may be necessary for right of way, if the route should vary from the present line of the canal, and to take and use any materials necessary for the prosecution of the work, their value to be determined in the manner provided by the general laws of the state.

4. The amount expended by the city of Chicago in deepening the canal according to the plan of 1836 shall be vested lien upon the Illinois and Michigan canal and its revenues after the payment of the present canal debt, provided the

cost shall not exceed \$2,500,000.

5. The state of Illinois may at any time relieve this lien upon the canal and revenue by refunding to the city of Chicago the amount expended in making the contemplated improvement and the interest thereon.

REPORT OF CITY COM, OF 1865.

Under date of March 6th, 1865, the city's Commission made its report to the Mayor and Common Council. This report gave in detail the plan for cleansing the Chicago river and was an important document. It is reproduced in full:

"The undersigned having been duly notified that they were on the 9th of January, 1865, appointed a Board of Commission to devise the best plan for cleansing the Chicago river, and having carefully considered the ques-

tions involved in this important subject, have the honor

to submit the following report.

Knowing that various modes of purifying the river had been proposed by gentlemen of intelligence having a direct interest in the subject, we resolved to avail ourselves as far as practicable of their opinions. Accordingly, at our first meeting, we caused a notice to be published requesting all persons who had formed any plans for effecting the object in view to present them with the necessary explanations. In response to this request a great number of communications were received, some of them containing valuable suggestions and showing that much thought had been bestowed upon the important questions involved.

We here desire to express our thanks to the parties who so kindly and promptly came forward to assist us in the solution of a difficult problem, and especially to those who had devoted much time to the preparation of

elaborate plans and estimates.

We do not deem it necessary to discuss, in this report, the merits of the various plans and suggestions which we have considered. Suffice it to say that at our different meetings we have endeavored to fully and impartially consider all their various merits and defects, and to give them all the weight to which, in our judgment, they were justly entitled.

These communications more or less directly bear upon three general plans which seem to be the only ones through which the main object in view can be accom-

plished, to wit:

Intercepting sewers which shall receive the filth that would otherwise flow into the river and carry it to the lake, to some point or points into which it would be pumped by machinery, thus keeping impurities out of

the river to as great an extent as practicable.

2. Cutting canals or making covered sewers from the two branches of the river to the lake, and by pumping works erected thereon force the filthy water out or the lake water in, thus keeping up a constant and sufficient current to keep the river pure. We do not believe that the necessary current can be produced by the natural action of the waves of the lake, as has been suggested.

3. Cutting down the summit of the Illinois and Michigan canal below the level of the lake, so that a sufficient quantity of water may be drawn from it to create the necessary current through the main river and the South branch (and perhaps, to some extent in the North Branch also) to thoroughly purify the same at all times.

Without recapitulating all the arguments which have been urged for and against these three general plans, it may be sufficient to briefly state a few of the prominent advantages and disadvantages of each.

The estimated cost of the third plan for purifying Chicago river, which is to cut down the summit of the canal below the level of the lake, so as to draw from it, at a low state, not less than 24,000 cubic feet of water

per minute, is \$2,102,467.50.

This estimate provides for increasing the capacity of the canal somewhat over the plan adopted by the Canal Commissioners in 1836, so as to create a current in Chicago river which is deemed sufficient to cleanse it. The quantity of water drawn from the lake through the river would seldom be less than 24,000 cubic feet per minute, and at the average stage of water much greater.

The advantages of this plan are briefly as follows:

1. It furnishes the only possible self-acting means of cleansing the main river and the South branch (and pos-

sibly to a certain extent the North branch also) every hour of the day, and every day of the year, for all time

to come.

2. The filth of the city which passes into the river will be drained off into the canal without contaminating the waters of the lake, and the continual current will prevent the water in the river from ever becoming very offensive.

3. The cost of construction will be the only expense to the city, as all subsequent expenses in keeping the channel open, and enlarging and improving it, will be borne

by the state.

4. The money expended in cutting down the summit of the canal, so as to procure the supply of water directly from Lake Michigan, will constitute a part of the expense of enlarging the present canal so as to admit the passage of steamboats of the largest class,—an improve-

ment which must soon be made.

5. By using the present summit locks, or, if the canal be enlarged, constructing other locks at each end of the 'deep cut' of the enlarged dimensions, a large quantity of water could be accumulated at any time by filling the canal to the present surface, which could be suddenly discharged into Chicago river, making a strong current to the lake. This may never be necessary, but the plan admits of the arrangement described, should it hereafter

be deemed desirable.

We have mentioned the prominent advantages of the plan. The principal disadvantages are its cost and the time which must be occupied in doing the work. The probable cost has been given. The time which would be required to execute the work economically, without seriously interfering with the navigation of the present canal, would be about three years.

But no other plan by which the river could be effectually purified could be executed in less than one year; so for a year, at least, some means within reach must be adopted to remedy the evils which it is intended ulti-

mately to entirely obviate.

It is believed that the hydraulic works at Bridgeport, if worked to their full capacity, or even so as to raise all the water which the present canal, with some slight additions to its banks, could discharge, would prevent the river from becoming very offensive, if especial vigilance were exercised to keep out delecterious substances. This we deem of the utmost importance, and, in fact, indispensable to the well being of the city, until some plan

of thorough drainage be carried out.

Even then, it appears to us, that the distilleries which have at times rendered the waters of the North branch almost putrid, and other establishments which have given Chicago a world-wide fame for its vile odors, should not be permitted to remain the nuisances which they have been. Certainly the process of thoroughly cleansing the river would be greatly simplified if no more offensive substances were discharged into it than could possibly be avoided. It would seem to be the part of wisdom as much to avoid an evil, if possible, as to cure it.

In view of all the facts of the case, the best plan for cleansing the Chicago river that we can devise, is to cut down the summit of the canal so as to draw a sufficient quantity through it from the lake to create the necessary

current in said river.

We are aware that the first cost of executing this work would exceed that of constructing short canals from the North and South branches to the lake and erecting the necessary machinery thereon. We are aware also that, theoretically, the interest on the additional cost would

be more than the expense of operating said machinery. But we do not think that in deciding this question we have a right to disregard other considerations of great importance to the interests of the city, especially the law passed at the recent session of our State Legislature which gives the city of Chicago a lien upon the Illinois and Michigan canal and its revenues after the payment of the present canal debt, until the whole cost of making the 'deep cut' and the interest accruing thereon shall have been reimbursed to the city.

With regard to the North branch, while we consider the proposed open canal from the lake to the river, along or near Fullerton avenue, the best plan to recommend for permanently cleansing it, if the discharge of filth into it must be suffered to go on as heretofore, we believe it is both the right and the duty of the city to prevent all such discharges. This would be by far the simplest, cheapest, and quickest way of purifying that branch; in fact, the only method we can think of to obtain immediate

as well as permanent relief.

It has often been said within the last three years, that any effectual prohibitions of such discharges would drive the distilleries from the city and thus inflict a serious blow upon its prosperity. By an Act of Congress, of last year, such heavy taxes were imposed upon distilled liquors as to cause the stoppage of these distilleries last July. But one has resumed work since, and that within the last two months. As a result the north and north-western portions of the city have enjoyed unusual freedom from unisances, which were often before of a most abominable character, while no complaints of any injury to the general growth or prosperity of the city have been heard of.

The proposed canal on or near Fullerton avenue would cost, as already stated, about \$500,000, and probably cost not less than \$20,000 annually afterward to maintain it, particularly if steam power should be required. It would be better for the city to pay now at least \$500,000 should that be necessary to prevent the North branch from being polluted, than to construct and maintain this canal, whatever may be the final necessity for keeping up an artificial current in said branch. We believe the true policy of the city is to prevent all nuisances, as far as possible, from being made, and then the unavoidable ones

will be comparatively easy to remedy. The proposed canal would probably encourage and increase, to a very great extent, filthy discharges into it and the river from establishments that would be, most probably, nuisances of

themselves to their neighborhoods.

The present sewerage system of the city has been planned and thus far carried out at some additional inconvenience and considerable expense, with reference to keeping the North branch as free as possible from pollution, for the purpose of avoiding the heavy expense that would otherwise be required to purify it. Up to this time there is but one sewer, and that only a few blocks long, on Chicago avenue, that discharges constantly into the North branch. The West Kinzie street sewer discharges into it during heavy rains only. The probability is that, for many years to come, the amount of sewage it may be necessary to discharge into that branch would not be of sufficient to cause offensiveness, if the establishments above mentioned, as well as similar ones, can be prevented from discharging their filth into it."

EFFORTS TO PURIFY THE CHICAGO RIVER.

By cutting away a temporary dam which had been thrown across the canal at Bridgeport to stop the flow of water from the river the final act in deepening the Illinois and Michigan canal was accomplished. This occurred on the afternoon of Saturday, July 15, 1871. "Quite a strong current was at once created, and an entire change of the water in the main river and the South branch was effected in about thirty-six hours." The water in the South branch is said to have become "quite clear and entirely free from noxious odors," and the favorable effect upon the water of the North branch

was perceptible.

The completion of this work was an impressive event in the history of the city. "No more important and necessary public improvement has ever been undertaken by the city," said the Board of Public Works. "The water of the river has become more and more filthy and offensive with the increase of our sewers having their outlet therein, and the absolute necessity of providing a way of carrying off this accumulation of filth has become more and more apparent. It is confidently believed that this will prove an adequate and permanent means of relief so far as the main river and the South branch are concerned."

The total amount expended by the city in deepening the canal was \$3,300,883.71. The discount on the canal bonds amounted to \$95,682.61, and the total of lost tolls paid by the city was \$43,501.07. By the Act of the Legislature authorizing the work the city was given a lien upon the revenues of the canal to the extent of \$2,500,000 and interest. As a compensation for the loss by the great fire of 1871 the Legislature, on October 20 of that year, appropriated \$2,955,340, with interest until paid, to relieve this lien. There was this provision in the Act that not less than one-fifth, nor more than one-third, of this sum should be applied by the city in reconstructing the bridges and public buildings and structures destroyed by the fire, the remainder to be applied to the payment of the interest on the bonded debt of the city and the maintenance of the fire and police departments.

OPENING OF DEEP CUT JULY 15, 1871.

For some years the effect upon the South branch was wholly satisfactory. "At all ordinary times now," said the chief engineer in 1872, "the water of Lake Michigan enters the mouth of the river, flows up it and the South branch to feed the canal, thus completely deordorizing what was so offensive and unbearable a year ago." "But observation as well as reflection shows," he said a year later, "that the purifying power of the canal is limited, and it will not do to suppose that any amount of filth, from a city of the size to which Chicago promises to grow, may be discharged into the river and branches for all time to come without producing injurious results."

ORIGINALLY AT OUTLET TO THE MISS. R.

By constructing an artificial waterway from Lake Michigan to Joliet, Chicago will restore an ancient outlet to the Mississippi. The great lakes were once an arm of the sea, like the Baltic in Europe. An upheavel of the earth left this body of water in a depression of its own. The tides of the ocean no longer swept through it, but its own overflow sought the sea in mighty rivers. Its surface was many feet, perhaps hundreds, higher than it is now. There is abundant evidence of this. Deposits of sand and clay containing fresh water shells on the shores of Lake Huron are found forty feet above the present water level, and extend back in some places twenty miles. Terraced deposits of alluvial material, indicating for-

mer water levels, extend along the shores at heights ranging from 120 to 200 feet. Seven ancient beaches were found by Logan at intervals up to a height of 331 feet above the level

of Lake Superior.

With such a volume of water in a great reservoir at the summit of the continental watershed, continually increased by melting glaciers and almost constant precipitation, the outfall both to the east and the west was enormous. passing of the glacial epoch the ice withdrew to the north, the waters settled in their individual basins, the bed of the channel to the eastward yielded to their corroding action and there has since been a continuous discharge through the St. The rocky ridge west of Lake Lawrence to the Atlantic. Michigan, like an imperfect dam, weakened at one point and a crevasse was opened through the solid limestone to a depth of 200 feet. For ages the waters of the lake were poured into the Gulf of Mexico, through this outlet, by way of the Mississippi valley. The trough hewn out of the rock for a distance of twenty miles, the bottom of which is only six feet above the present level of the lake, is from one to two miles in width. It may be said to begin at Summit, eleven miles west of Lake Michigan, and to end at Lockport, twenty miles further west and south. It is in the bed of this natural outlet that a new channel is now being excavated, of sufficient depth to renew the outflow from the lake.

In Worthen's "Geological Survey of Illinois," M. H. Bannister says it is evident, with very little observation, that at a comparatively recent period, subsequent to the glacial epoch, a considerable portion of Cook County was under the waters of Lake Michigan, which at that time found an outlet into the Mississippi valley through the present channel of the Des-The deposits of this period consist of beds of stratified sand and gravel in the central and eastern portions of the county, either underlying the flat prairies or arranged in the form of ridges, skirting the shores of the lake, and in one or two cases trending westward away from it to a distance of several miles. These ridges, he says, seem to indicate the shores of the ancient bay, which with these boundaries would require the level of Lake Michigan to be nearly forty feet higher than at the present time. The outlet was evidently near Summit, where an alteration of the level for a very few feet would send the waters of the Chicago river into the Des-

Another very evident outlet, to the south of this was through the channel utilized by the Calumet feeder, joining the Desplaines at the Sag. The mound or ridge at Blue Island, Mr. Bannister thinks, must be referred to this level of the waters. He found numerous evidences of a powerful stream on the rocks at Athens, in the shape of waterworn surfaces, potholes, etc. The nearest ridges running parallel to the present coast line, appear to him to indicate a very gradual recession of the waters of the lake, before reaching its present limits. The structure of these ridges, he finds, is similar to that of beech deposits, generally consisting of irregularily stratified sand and gravel beds, with sometimes a thin seam of vegetable mold. This structure, he adds, is well displayed on the lake shore north of the University grove at Evanston, where the wearing action of the lake storms upon the shore has cut down one of the ridges upon which the town is built.

Frank H. Bradley, who wrote the geological history of Will county for the same work, says that throughout the valley of the Desplaines, Du Page and Kankakee rivers the alluvial deposits constantly remind the observer that Will county once bordered the lower end and the outlet of Lake Michigan. The mounds along the Desplaines which were formerly attributed to the industry of the aboriginal mound builders, are, to him, evidently the islands and banks of the old western outlet.

There are varying opinions as to the manner in which this outlet was created. Worthen says of all the river valleys of the state, that if we could strip off from the surface the superficial deposits of sand, clay and gravel, varying in depth from ten to one hundred feet, we should find broad and deep valleys, cut into the solid rock strata to a depth varying from one hundred to three hundred feet. It is his opinion that these valleys were excavated, in part, at least by streams of water, but that they may have been greatly enlarged by the joint action of ice and currents of water, perhaps during a period of submergence, and were afterward filled, either wholly or in part, by the superificial material called drift which now occupies them.

Ossian Guthrie, whose name has been associated with every effort of the past forty years to renew an outlet to the Mississippi, and who has made personal investigations of the physical conditions, believes that the Desplaines valley was excavated by glacial action. In a paper read before the Geological Society of Chicago he estimates that the glacier, which, he believes, once occupied the bed of Lake Michigan was 2,500 feet in height above the present surface of the lake at its southern extremity, and 16,000 feet in height at its source. He traces the course of this glacier by its moraines, and con-

cludes that it turned to the westward at the present location of Chicago and ploughed its way through the rocky divide. There were two channels, one by the way of Mud Lake and the other by way of the Sag. "Hundreds of acres of rock, easy of access and in many places exposed to view," he says, "are glacial scored and plainly indicate this; and along both channels glacial debris is scattered in such variety and profusion that it would seem to be more difficult for the geologist

to lose the glacial trial than to follow it."

A remnant of the ancient stream is found in the Desplaines river, which now, a mere thread, winds through the valley over its rocky bed. This river rises in the southern part of the state of Wisconsin, and flows southward parallel with the western shore of Lake Michigan, twelve to forty miles distant. At Summit it turns abrutly to the southwestward and follows the valley to a point sixty miles below Chicago where it unites with the Kankakee to form the Illinois. The Illinois river continues southwestward across the state emptying into the Mississippi at Grafton, 325 miles from Chicago. From Chicago to Romeo, a distance of twenty-seven miles, the bed of the Desplaines river is six feet above the level of Lake Michigan. From Romeo to Joliet a distance of ten miles, there is a descent of seventy-seven feet, the greater part of it below Lockport. From Joliet to LaSalle, a distance of sixty miles, there is a further descent of seventy feet. From LaSalle to the mouth of the Illinois, 225 miles, the fall is only twenty-seven feet.

It is more than two hundred years since the Desplaines valley was discovered, but it became at once the path of communication between the previously settled portions of Canada and the valley of the Mississippi. History gives the credit of the discovery to Joliet and Marquette, but it is certain that French traders penetrated this region many years earlier. The latter faced the perils of exploration solely for purposes of gain, and have left no records of their discoveries and their transactions with the Indians. Organized exploration in the western parts of America was prompted by a desire

to discover a waterway across the continent.

DESCRIPTION OF MUD LAKE.

Mud Lake is well described by its name, but it deserves a recognition which the name does not suggest. As the waters of Lake Michigan receded in prehistoric times, the Chicago divide, stretching from Summit to Lemont or beyond, became

a permanent barrier against the outflow toward the Mississippi, and alluvial deposits formed a second barrier in the vicinity of Bridgeport. In the depression between the Desplaines and Chicago rivers was thus created a pond or lake that stood at the summit of the watershed which separates the St. Lawrence and the Mississippi basins. For its own supply it depended upon the freshets of spring and autumn, its stagnant waters during the remaining months of the year furnishing sustenance for lillies, reeds and marsh grasses, and a home for every variety of the smaller amphibious animals. When its little basin was filled to overflowing it discharged its waters in both directions,—into the Mississippi by way of the Desplaines, and into the St. Lawrence by way of the Chicago river and the great lakes. To Le Petit Lac, as the wandering French Canadians called it, belonged the exclusive distinction of contributing to two of the greatest river systems of the world.

The dimensions of this lake were gradually contracted, and a strip of land varying in width from a mile and a half to three miles separated it from the Desplaines in the time of Joliet, Marquette and LaSalle. By them it was called the Portage. The Chicago river had its origin at the eastern extremity of Mud Lake, not far from the present location of Kedzie avenue. It is less than twenty years since this lake lost its identity, but its former bed was covered with water at every overflow of the Desplaines, until the latter was permanently diverted to a new channel by the Trustees of the

Sanitary District in 1893.

HISTORICAL ACCOUNT.

In 1817 Samuel A. Storrow, judge advocate of the United States army, made a three months' tour through the west. An account of his trip appears in a letter of Major General Brown, dated December 1, of that year. He speaks of the Chicago river as deep and about forty yards wide. His attention was attracted to the interesting fact of the division of the waters at its source, part flowing eastward to the lake and part westward to the Mississippi, and he commented on the practicability of a permanent waterway. He says:

"Before it (the river) enters the lake its two branches unite, the one proceeding from the north, the other from the west, where it takes its rise in the very fountain of the Plein, or Illinois, which flows in an opposite direction. The source of these two rivers illustrates the

geographical phenomenon of a reservoir on the very summit of a dividing ridge. In the autumn they are both without any apparent fountain, but are formed within a mile and a half of each other by some imperceptible undulations of the prairie which drain it and lead it to different directions. But in the spring the space between the two is a single sheet of water, the common reservoir of both, in the center of which there is no current towards either of the opposite streams. This circumstance creates the singular fact of the insulation of all the United States excepting Louisiana, making the circumnavigation of them practicable from the Gulf of St. Lawrence to that of Mexico, with the single hindrance of the falls of Niagara. The Chicago forms a third partition of the great country I had passed. The Ouisconsin and Fox rivers make a water communication between the Mississippi and Michigan, with the exception of four miles. The Millewackie and River a la Roche, the same, with half the exception. The Chicago and de Plein make, in the manner I have described, the communication entire. The latter should not escape national attention. The ground between the two is without rocks, and with little labor would admit of a permanent connection between the waters of the Illinois and Michigan."

REPORT OF ALBERT GALLATIN.

Complying with this order Albert Gallatin, secretary of the treasury, made a report on roads and canals to the Senate on April 6, 1808. This was a very complete statement of the condition of the roads and canals then in existence or in preparation and contained definite plans for a system of in-

ternal improvements.

"The inconveniences, complaints, and perhaps dangers, which may result from a vast extent of territory," he said, "can not otherwise be radically removed or prevented than by opening speedy and easy communication through all its parts. Good roads and canals will shorten distances, facilitate commercial and personal intercourse and unite by a still more intimate community of interests the most remote quarters of the United States. No other single operation within the power of Government can more effectually tend to strengthen and perpetuate that

union which secures external independence, domestic

peace and internal liberty."

Referring to the natural communication between Lake Michigan and the Mississippi he said of the Illinois River, that it "rises in a swamp which, when the waters are high, affords a natural canoe navigation to the sources of Chicago creek, a short stream, which falls into Lake Michigan at its southern extremity." He did not doubt that if the inland navigation between the western rivers and the lakes was completely opened the whole Indian trade, either of the Mississippi by Lake Michigan, or of the Northwest by Lake Superior, must necessarily center in an Atlantic port of the United States, a consideration of minor importance as a commercial object when compared with the other advantages of that great communication, but of great weight in its relation to the political intercourse of the United States with the Indians. His estimate of the cost of the improvements to reach Lake Michigan was \$16,600,000; to reach the Mississippi, \$20,000,000. raise this sum he suggested that the Government sell ten million of its one hundred million acres of public lands. He believed the increase in the value of the remaining ninety million acres would more than repay the outlay. His report was referred to a committee and a week later 1,200 copies were ordered printed. That was the only official recognition it received, probably because Congress was in daily fear that it would exceed its constitutional powers.

Speech of Peter B. Porter in Congress February 8th, 1810. In the House on February 8, 1810, Peter B. Porter of New York rose to discuss the internal improvements of the United States by roads and canals. He said he had listened to appeals for the protection of commerce. It was to be presumed that Congress would be as willing to give a direct encouragement to agriculture as to do it indirectly through the medium of commerce. He referred to the bill introduced in the Senate by Mr. Pope, in the preparation of which he had had a part. Some great system of internal navigation, such as was contemplated in that bill, was not only an object of the first consequence in the future prosperity of the country, considered as a measure of political economy, but as a measure of state policy it was indispensable to the preservation of the integrity

of the Government. . .

Proceeding to show by geographical detail both the importance and the practicability of such navigation, he found west of the Alleghenies "a scene of natural internal navigation un

equalled in the world." To the south and the west of the

great lakes

"the waters of the Ohio and the Mississippi approach within short distance of and are interlocked by the waters of the lakes. The lands along these dividing waters are generally level, and the rivers are navigable and might be connected by short canals at little expense. At the southwestern extremity of Lake Michigan, the most inconsiderable expense would open a canal between the waters of that lake and the Illinois river, one of the principal branches of the Mississippi. Nature has already made this connection nearly complete, and it is not uncommon for boats in the spring of the year to pass from the lake into the Illinois and from thence by the waters of the Illinois and Mississippi to New Orleans without being taken out of the water."

REPORT OF JOHN C. CALHOUN.

John C. Calhoun, when secretary of war, suggested to Congress in a report made on January 14, 1819, a plan for the application of such means as were within the power of Congress for the purpose of opening and constructing roads and canals that might deserve and require the aid of the government with a view to military operations in the time of war. Enumerating certain routes worthy of consideration he said:

"If to those communications we add a road from Detroit to Ohio, which has already been commenced, and a canal from the Illinois river to Lake Michigan, which the growing population of the State of Illinois renders very important, all the facilities which would be essential to carry on military operations in the time of war, and the transportation of the munitions of war for the defense of the western portion of our northern frontier would be afforded."

Mr. Calhoun transmitted with his own report one made by Major Stephen H. Long, dated May 12, 1818, giving an account of a tour of exploration in the West the year previous. Major Long said a canal uniting the waters of the Illinois river with those of Lake Michigan might be considered the first in importance of any in this quarter of the country, the construction of which would be attended with very little expense compared with the magnitude of the object.

CONGRESSIONAL ACTION.

Illinois became a state in 1818. Daniel P. Cook, a son-in-law of Governor Edwards, was its second representative in Congress, serving from 1819 to 1827. He devoted himself assiduously to the interests of the proposed canal. Through his influence the Illinois State Legislature of 1820-1 had a partial survey of the route made, sufficient to demonstrate the practicability of the undertaking. A report of this survey was laid before Congress by Mr. Cook on December 7, 1821, with this resolution.

"That the committee on public lands be instructed to inquire whether any, and, if any, what provision is necessary to be made to enable the State of Illinois to open a canal through the public lands to connect the waters of Lake Michigan with the Illinois river."

As an illustration of the opposition to the implied co-operation of the United States it may be noted that John Floyd of Virginia thought that Congress had already sufficiently evinced its liberality to the new States. On a former occasion he had proposed a resolution to appropriate a portion of the public lands for the endowment of colleges. resolution had received the decided opposition of the new States. A constitutional question was raised on the subject, which, if it did not convince, at least it created so much doubt in his own mind as to induce him to forbear to press it. Nor could he, in the present instance, as a member of a State which had done as much at least as any State in the Union for the general benefit, consent to a proposition of this sort. As well might Virginia ask for an appropriation of the public funds for the purpose of completing canals to the city of Richmond. He was disposed to leave the subject of canals to the energy and ability of those States through which they passed and for whose benefit they were intended.

Mr. Cook replied that he did not expect a proposition so reasonable as he conceived this to be would meet with opposition. The States northwest of the Ohio felt grateful for all the favors they had received, but in the present case no favor was asked. The object of the resolution was not to solicit a donation from the General Government to assist in making the canal, but merely to reserve a narrow strip of land in the direction of the contemplated canal and through which it should pass. By this measure the Government instead of impairing its funds, would increase them. Such an

act would undoubtedly enable the Government to dispose of the reservation afterward at a price greatly enhanced and at the same time virtually authorize the government of Illinois to go on with its contemplated undertaking. The resolution

was adopted.

A few days later the matter was brought to the attention of the Senate by Jessie B. Thomas of Illinois, who presented on December 19, 1821, a resolution adopted by the Illinois State Legislature praying to be authorized to construct a canal connecting the waters of Lake Michigan with the Illinois river, and asking for the donation of a certain quantity of land for that purpose. This was referred to the committee

on roads and canals.

Resolutions and debates at last begun to bear fruit, although of doubtful quality. In the House on January 14, 1822. Christopher Rankin of Missouri, for the committee on public lands to whom the matter had been referred, reported a bill authorizing the State of Illinois to open a canal through the public lands, and a similar bill was introduced in the Senate on January 24, 1822, by Mr. Thomas. Having passed both Houses, it became a law on March 30, 1822. The Act reserved ninety feet of land on each side of the canal from any

sale to be made by the United States.

"The use thereof forever," said the bill, "shall be, and the same is hereby, vested in the said State for a canal, and for no other purpose whatever; on condition, however, that, if said State does not survey and direct by law said canal to be opened, and return a complete map thereof to the treasury department, within three years from and after the passage of this Act; or, if the said canal be not completed, suitable for navigation, within twelve years thereafter; or, if said ground shall ever cease to be occupied by and used for, a canal suitable for navigation, the reservation and grant hereby made shall be void and of none effect."

Congress took care that this meager grant should not carry with it any liabilities. It was provided that nothing in the Act should be construed to imply any obligation on the part of the United States to appropriate any money to defray the expense of surveying or opening the canal; also, "that the said canal, when completed, shall be, and forever remain, a public highway for the use of the Government of the United States, free from any toll or charge whatever, for any property of the United States, or any persons in their service,

passing through the same."

Permission to construct a canal through the lands owned by the United States was in no sense an aid to the young and struggling State of Illinois. Its population at this time was less than 60,000 and the people were unable even to pay for the survey of the route of a canal. It had been repeatedly shown that the proposed work was, at that time, of greater National than State importance, and every public officer of the National Government who had given any attention to the canal had recommended its construction. Not only were the indirect advantages apparent, but it was acknowledged by all that there would be a direct financial gain to the Government, if it were to donate sufficient land to pay for the work, in the increased value of the unappropriated lands. Mr. Cook was not disposed to accept a questionable favor, and on behalf of the state, he renewed his appeals in Congress for something like a reasonable recognition of the undertaking. On March 26, 1824, on his motion, the House committee on roads and canals was instructed to inquire into the expediency of vesting in the State of Illinois, for the purpose of defraying the expense of opening a canal between the waters of the Illinois river and Lake Michigan, the land bordering on the proposed canal that had been reserved from sale by Congress.

In the following year this committee reported in favor of the appropriation. Among other suggestions it urged that, in a political point of view, its importance would be found not less imposing than in either of those in which it had already been viewed. In uniting and drawing together the interests of the remote extremities of the eastern, the southern and the western sections of the Union, no work of the same magnitude, it was believed, could be more effectual. The geographical position of Illinois and Missouri, the two States particularly interested in it, was such that they would under the advantages of this communication, have a common and almost equal interest in preserving their connection with the North and the South. Their trade would ultimately flow through the lakes and the Mississippi, and the advantages of a choice of market would be so important to them that they must ever be unwilling to surrender it. By the reference to the map of the country, it would be seen that these States would have it in their power at all times, in the event, should it unfortunately ever occur, of any internal commotion, to command the waters of the Ohio and Mississippi, From their commanding position, therefore, as well as from their capacity to sustain a dense, and it must mainly be a free population, they would always hold the balance of power in deciding every effort that might be made to separate the West from either or both of the great geographical divisions of the Union; and if from no other cause, their interests would direct their exertion of that power in favor of the Union. Nor was the interest of these States in preserving a free outlet for their commerce both through the lake and the Mississippi, the latter of which opened to them the New Orleans, the West Indies and South American markets, stronger than must be that of the North and South in being united with them.

The feeling among the people of Illinois was reflected in a letter written by ex-Governor Edwards to Henry Clay in 1825, just after the latter had been chosen secretary of state

by John Quincy Adams. Mr. Edwards said:

"A favorite object and, indeed, a political hobby that supersedes all others in this state and Missouri, is a canal to conect Lake Michigan and the Illinois river. Nothing could sustain the administration or its friends in these two States so effectually as its countenancing this measure."

The writer ventured to suggest that it might be very judicious in the President, without descending to any particular case, to introduce in his message to Congress some sentiment favorable to the connection of the great lakes with the Atlantic and western waters. He knew it would contribute greatly

to the support of the administration.

In its anxiety to have the work on the canal begin the Illinois State Legislature, on January 17, 1825. incorporated the Illinois and Michigan Canal Association and granted it extraordinary privileges. It was provided in the charter of the association that all cessions, grants and transfers made, or that might thereafter be made by the Government of the United States, for the purpose of promoting the construction of the canal, should be vested in that corporation. Congress is said not to have approved of the State's giving away valuable privileges in advance of their possession, and the Act nearly deprived the State of any future grant of lands. Mr. Cook was alarmed over the action and hastened to advise the State Legislature to repeal the Act. The incorporators finally surrendered their charter, but not until Mr. Cook

had sent an address to the people of the State, setting before them the interest which the National Government had in the

undertaking.

"This is a work," he said, "in which the nation is interested, and which the General Government should, therefore, aid in executing. As a ligament to bind the Union together, no work of the same magnitude can be more useful, Occupying, as Illinois and Missouri do, a central position in the great semicircle of States on the north and west, and commanding, as they do, the commerce of the three great rivers of the West, the Ohio, Mississippi and Missouri, they may well be called the keystone of the widely projected arch. From New York to Louisiana, following the frontier curve of that portion of the Union, in the event of any political commotion or extempt at separation, the influence of these States would, ere long, be sensibly felt, and would even decide the contest. And their interest will be so happily balanced, by their desire for a free outlet through both the Mississippi and the lakes, that so long as commercial advantage continues to influence the policy of States, they must and will decide against disunion. friends of the Union, therefore, have a strong interest in this communication."

Having undone an injudicious act of the people at home, Mr. Cook redoubled his efforts in impressing upon Congress its duty in the matter of extending substantial aid to the canal. On December 30, 1824, he moved a resolution in the House providing that a committee be appointed to inquire whether any, and, if any, what provision it would be proper or practicable to make to aid the State of Illinois in opening a canal. By way of explanation he said it was not likely the State, from its ordinary means, could carry the measure already passed by Congress into effect. Congress had given to the State of Illinois a certain proportion of the net proceeds of the sales of the public lands for the encouragement of learning. If no better means should present themselves, and if the Government of the United States should not consider the canal, in a national view, of so much importance as to construct it at its own cost, the State might be allowed to convert its school lands into a fund for the purpose of making the canal, and to apply the tolls from the canal to school purposes, thus merely changing the land into a canal stock, the profits of which to be applied to the same purpose the land was to serve, that of encouraging learning. The canal was really a national object, worthy of the employment

of the national means.

After a number of discouraging postponements, Mr. Cook succeeded in getting his resolution before a committee, and in the following year a bill was reported. This was the basis for the Act under which the Illinois and Michigan canal was constructed. The bill was repeatedly postponed, lost and reconsidered, and there were many acrimonious debates. One member went into a calculation to show that the proposed grant of lands would not only defray all the expenses of the canal, but would leave a balance in the Illinois treasury of \$500,000 to \$1,000,000. Another denied that Illinois had any better right to a portion of the public lands than Virginia or any other State. The lands, when ceded, were to be set apart to pay the public debts, but Congress appeared to have forgotten that stipulation, and the lands, it seemed, were to be given to any person who lived nearest to them. Would it not be best, he asked, to sell the whole at once and divide the proceeds?

Charles Miner of Pennsylvania, wanted the bill recommitted with instructions to the committee to inquire into the expediency of subscribing on behalf of the United States for stock in the proposed canal, to an amount not exceeding one-third of the whole, the stock to be paid for out of the proceeds of lands on or near the route. He avowed his decided hostility to the bill. What did it propose? To give to the State of Illinois alternate sections of land along the whole line of the proposed canal from Lake Michigan to the Illinois What was the extent of this grant? It was estimated at about 200,000 acres; but, as the extent of the line of the canal was indefinite, so the grant was indefinite. Illinois might make the canal only fifty or sixty miles long and demand 200,000 acres; but she might extend the canal down the Illinois along the whole extent of the State, and under the bill, demand 500,000, 800,000 or 1,000,000 acres. Such uncer-

tain, indefinite grants were extremely objectionable.

"On the line of the canal," said Mr. Miner, "villages, towns and cities will grow up. Some of the tracts will be of great value. Take them all together it will not be an unfair estimate to put them at \$5.00 an acre. Suppose the canal sixty miles in length and the land given 200,000 acres. You give then \$1,000,000 to Illinois. The canal is estimate to cost from \$600,000 to \$800,000 so that

you make the canal and give a bounty to that State besides. Who makes the canal? Those who furnish the The people of the United States make the canal, funds. and then they are to be taxed to all enduring time for liberty to use it. This seems to me a wild waste of the public domain. I entreat you, gentlemen, to pause before you make this excessive grant. In my opinion it will bring a system of internal improvements more into disrepute than all the arguments of its enemies. Pennsylvania came this session, I will not say cap in hand and with bended knee, but in the most respectful manner, and asked the grant of one little township for her institution for the deaf mutes, -- poor dumb mouths; they could not plead for themselves. What was the answer? This petition was rejected,—this request was refused. now you propose to give to Illinois 200,000 acres. hope the bill may be recommitted."

The bill was not recommitted, nor was it otherwise delayed. It passed both the House and the Senate on March 2, 1827, the day on which Mr. Miner made his vigorous opposing speech, and was at once approved by the Executive. Much credit is due Mr. Cook for his persistent and eloquent advocacy of the bill. Through his influence the Legislature of Illinois was called together in special session in January, 1826, and the following memorial to Congress was adopted:

MEMORIAL OF ILLINOIS,

"The memorial of the General Assembly of the State of Illinois respectfully represents: That the construction of a canal, uniting the waters of Lake Michigan with the Illinois river, will form an important addition to the great connecting links in the chain of internal navigation, which will effectually secure the indissoluble union of the confederate members of this great and powerful Republic. By the completion of this great and work, the connection between the North and South, the East and the West, would be strengthened by the ties of commercial intercourse and social neighborhood, and the union of the States bid defiance to internal commotion, sectional jealousy and foreign invasion. States of the Union would then feel the most powerful motives to resist every attempt at dissolution. To effect so great and desirable an object your memorialists believe to be of sufficient importance to engage the attention and awaken the munificent patronage of a Government whose principle of action is the promotion of Your memoralists are the general welfare. alive to the spirit of improvement that mainfests itself in almost every section of our extensive country, and would fain lend a helping hand in so great and good a cause; their situation, however, forbids their doing much, without the aid of the Federal Government, into whose treasuary almost all the funds, whether brought hither by immigrants, or earned by the industry of their citizens. are paid for the purchase of the public lands. While this state of things shall continue, and the money thus paid into the treasury of the Union is taken out of our State, our people will not be able to engage in the glorious work

of improving our common country.

Ought the people of this State stand by, with folded arms, and behold the great work of internal improvement progress in other States, without making an effort to improve their own condition, and at the same time advance the interest of our beloved country? A condition thus paralyzed is at war, not only with our interests, but with the best feelings of our hearts. Did this State possess the public domain lying within its bounds, as is the case with older members of this confederacy, your memorialists would not appear before your honorable body to solicit aid in this important work. If, as your memorialists believe, the construction of the canal would be highly beneficial to the Union at large; if the receipts into the treasury of the United States would be augmented by the increased sales of the public lands, and if the interests of the State would be also advanced thereby, is it unreasonable to apply to a paternal government for assistance in the promotion of such beneficial ends! It is unnecessary for your memorialists to enlarge on the great advantages of this canal to the Union, in the facilities to be afforded in the event of a war either with the Indian tribes inhabiting our frontier, or the British Nation. Your honorable body is aware that this State is situated on the borders of an Indian country filled with numerous and powerful tribes of the sons of the forest. If our country should be again engaged in war, the saving of expense in the transportation of the munitions of war would alone defray the expense of the contemplated canal, and justify the United States in making a liberal

appropriation for its construction.

Your memorialists do not, however, ask your honorable body to appropriate money out of the treasury to aid them in this work. They only ask for a tract of land, through which the contemplated canal may pass, and which for a series of years will be wholly unproductive to the Government, unless the canal shall be commenced under auspices favorable to its construction, in which event all the land in its vicinity would immediately become available to the United States. Your memorialists sincerely believe that a liberal appropriation of land for this object would, even in a pecuniary point of view, be of immense importance to the treasury of the Union. The public lands in the vicinity would not only sell, but at a considerable advance of the minimum price. Should this opinion be correct (and does not experience justify it?) the United States would be gainer by the proposed donation to the State.

Your memorialists further state, that, at their last session, they passed an act of incorporation, upon very liberal terms, authorizing a company to construct the projected canal; but the remoteness of the country from the residence of capitalists has prevented them from engaging in the work. At their present session, your memorialists have repealed the charter, and their only hope of soon beginning the work depends upon the liberality of your honorable body. Your memorialists have caused the route to be explored and estimates to be made of the probable expense of the work, from which it appears that the cost of constructing the canal will not be less than \$600,000 and may possibly amount to \$700,000.

To the end, therefore, that your memorialists may be enabled to commence and complete this great work, we pray your honorable body to grant to this State the respective townships of land through which the contemplated canal may pass, the avails of which to be appropriated exclusively to the construction of said canal, upon such terms and conditions as to your honorable body

may seem proper."

The bill which this memorial must have aided greatly in

passing enacted:

"That there be and hereby is granted to the State of Illinois, for the purpose of aiding the State in opening a canal to unite the waters of Illinois river with those

of Lake Michigan, a quantity of land equal to one-half of five sections in width, on each side of said canal, and reserving each alternate section to the United States, to be selected by the commissioner of the land office, under the direction of the President of the United States, from one end of the said canal to the other; and the said lands shall be subject to the disposal of the Legislature of the said State, for the purpose aforesaid, and no other: Provided, That the said canal, when completed, shall be and forever remain a public highway for the use of the government of the United States, or persons in their service passing through the same: Provided, That said canal shall be commenced within five years, and completed in twenty years, or the State shall be bound to pay to the United States the amount of any lands previously sold, and that the title to purchasers under the State shall be valid."

PERIOD OF CANAL CONSTRUCTION.

Contracts for the first work on the Illinois and Michigan canal were let on June 6, 1836. The line was divided into three divisions, Summit, Middle and Western. The Summit division extended from the North fork of the South branch of the Chicago river to the first lock at Lockport, but incidentally included the river, about five and one-half miles in length. It was proposed originally to construct a towpath along the south side of the South Branch from the "point," or junction of the North and South branches, crossing the river by a bridge at the mouth of the North fork up which it would continue to the mouth of the slough. The eastern terminus was subsequently changed to its present location.

Chief Engineer Gooding found the prairie over which the line was run to be level and extremely wet except in times of severe drought. The cutting would be chiefly through a stiff blue clay, he said, from seven to nineteen feet deep. In his description of the route he said the canal would continue down the valley of the Desplaines. For thirteen or fourteen miles the river had little descent. The current at low water was scarcely perceptible, and the land along its borders was so low as to be overflowed at every slight rise of the water. After the line of the canal entered the valley the direction was changed by a gentle curve and another straight line obtained of 3½ miles. There were several other straight lines on this division and the curves were all gentle and uniform.

The depth of cutting continued about the same down the valley to Brewer's Ford. From that point the engineer announced that the cutting would be very much more expensive as the excavation was principally in rock. The depth of earth in rock above the mouth of the Saganshkee swamp was found to be much less than was anticipated. A difficult section of canal was encountered in crossing the mouth of the swamp where there was earth to the depth of five or six feet, the most of which was in a semi-fluid state, resting upon rock. The

cutting here was about 174 feet.

From this point to the first lock the rock was generally near the surface. The level ran out a short distance after the crossing Big Run, which was about 1½ miles above the first lock and in the bed of which the cutting was about two feet. The first two locks were located on section 23, town 36 north, range 10 east of the third principal meridian, on land belonging to the State. The canal or basin, for about three-fourths of a mile above the first lock was planned to be 120 feet in width. The length of the canal from the beginning to the first lock was 34 miles and 35.78 chains. The estimates on the Summit division were for a canal 60 feet wide at the surface, 36 feet wide at the bottom in earth and 48 feet in rock, and six feet deep. A declivity was given to the bottom of

the canal of one-tenth of a foot per mile.

The rock was found to be stratified limestone, the greater part of which, it was believed, could be quarried without much difficulty. The strata adhered to each other so closely as almost entirely to prevent the water from flowing between them, as was feared it might do. The strata were generally from two to six inches thick and of a quality, it was said, suitable for building purposes. The expense of constructing the Summit division of the canal and the time required for its completion were found before the end of the first year of construction likely to be much greater than was anticipated, but nothing had occurred to diminish confidence in the practicability of the work. The average price at which the contracts for the excavation in earth in the Summit division were let was 33.35 cents per cubic yard, and for that in rock \$1.54.

When proposals were advertised for in the spring of 1836 there were no contractors in this part of the country and no mechanics or common laborers when the contracts were awarded in June. It was with difficulty that the contractors could secure workmen to build their shanties, or teams and

tools with which to begin work. Operations were formally begun on July 4, 1836. The occasion was a memorable one, and Chicago was in a state of considerable excitement. a signal given by three cannons at Fort Dearborn the citizens assembled in the public square and moved in a body to the scene of the inaugural ceremonies at the head of the proposed canal. Some went by boat and others on foot or with teams along the Archer road. The steamer Chicago started from the foot of Dearborn street with her crowded and proceeded up the river. Two schooners and other vessels towed by horses followed, carrying as many

people as could crowd upon them.

The locality where the canal was to connect with the Chicago river had been named Canalport and a public house called the New House opened. The crowd collected in front of this public building and saluted Judge Smith as he solemnly read the Declaration of Independence with the characteristic enthusiasm of a pioneer audience. Dr. W. B. Egan followed with an eloquent address, and Gurdon S. Hubbard spoke of the promising condition of the settlement as compared with that of the one he had found eighteen years previous when he ascended the river in a canoe. When one of the speakers in his exuberance of feeling ran along the scale of years and boldly prophesied that Chicago in a hundred years would have a population of 100,000 he excited the ridicule of his hearers and was booted off the barrel from which he was Ground was afterward broken for the canal by Colonel Archer, acting commissioner. Addresses by Judges Smith and Brown of the Supreme Court and Commissioner Hubbard followed.

Work was soon begun, but few laborers were to be had until about the close of the year, when there were 350 at work along the entire line, or so much of it as was under contract. The scarcity of laborers and sickness were the principal causes of delay throughout the entire period of construction.

By the Act of March 2, 1837, the appointment of Canal Commissioners was taken from the Governor and their election assumed by the Legislature. With a more direct interest in the work than it previously had the Legislature appointed a committee to inquire into the probable cost of a canal of the dimensions authorized. Out of the report of the committee grew a dispute over the propriety of continuing the deep cut, the committee contending that the estimates of the chief engineer were far too low, and the engineer maintaining that

the work could be done for less than he had estimated. committee was right and the engineer wrong. But the discussion was dropped within a year and the work continued on the deep cut plan. It was not until the State was absolutely unable to raise the money to carry on the work that it accepted the alternative of a shallow cut and pumping works.

An incident of interest is found in the optimism of Chief Engineer Gooding which seems to have been shared by the Commissioners. By a revision of the plans in 1836 it was provided that the canal in passing through the Town of Lockport should be 120 feet wide. A hydraulic basin was to be constructed in such a manner that the mills or manufactories which, it was assumed, would spring up there, might be built upon the banks of the basin and be operated by the water drawn from it. Upon the side of the buildings next to the canal, and separated from it only by the towpath, there were to be a street and a tier of warehouse lots. The basin was to be connected with the canal in such a manner that boats or vessels could readily pass into it and load or unload at the mills or warehouses.

The value of the water power created there and at other points along the canal, by drawing a supply directly from Lake Michigan, could be fully appreciated, Mr. Gooding said, after a season of such severe drought as the previous one had The Desplaines River and many other considerable streams of the country had been nearly dried up, and probably three-fourths of the water mills throughout a large portion of the United States had been standing still for the preceding three or four months. Had the canal been completed there would have been during the season an unusual supply of water, as the surface of the lake had been nine feet and four inches above canal bottom, three feet and four inches higher than was originally counted upon.

Again Mr. Gooding expected phenomenal results at the Sag. "When the canal at this point is completed the present plan," he said, "a quantity of state land amounting to about 270 acres will be reclaimed, which is at present entirely valueless. The whole of the impassible marsh that now presents so forbidding an appearance will be made dry land."

On March 2, 1837, the legislature had authorized a survey and estimate to be made for a canal, diverging from the main trunk of the Illinois and Michigan Canal, through the Ausauganashke swamp and lake, to intersect the Calumet River at the nearest practicable point, the work to be constructed whenever the State of Indiana should undertake a corresponding work connecting her system of internal improvements with the Illinois and Michigan Canal. "The junction of the canal from the Calumet River with the main line being made at this point upon reclaimed state land," said Mr. Goodling, referring to the Sag, "will make it one of the most valuable town sites upon the line of the canal, or in the state."

Estimates made by E. B. Talcott, resident engineer in charge of the Summit division of the canal, on December 10, 1837, provided for turning or pivot bridges, the engineer believing that it would be frequently found advantageous to the commerce of the country for lake vessels to navigate the canal as far as Lockport. The formation of a basin at the forks of the Chicago River considered as part of the general plan of the canal, was also embraced in his estimates, and the Legislatre, by Act of July 21, 1837, authorized the enlargement of "the natural basin at the confluence of the North and South branches of the Chicago River so as to render the same as useful and convenient as possible."

The many extravagant schemes for internal improvement projected in 1837 injured the state's credit, and canal lands were not easily sold. On April 11, 1839, the Canal Commissioners ordered an issue of checks or scrip payable in ninety days. The total amount issued for that year was \$394,554. This was used in paying the estimates of contractors and meeting other direct expenses. In 1840 the contractors agreed to take \$1,000,000 worth of state bonds at par to 25 per cent. discount. These bonds carried the work along until March, 1843, when the expenditures could no longer be met and the work was entirely suspended. More than \$5,000,000 had been spent

and the canal was still far from being completed. The expenditures by years were as follows:

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Total \$5,139,492.03

It became apparent at last that the resources of the state, aided by the unproductive sales of the canal lands, were en-

tirely inadequate to the completion of the canal on the basis of the deep cut. Reluctantly it was agreed by every one that a shallow cut must be made, and that water to operate the canal must be obtained from some other source than Lake Michigan. It had been shown that it was impracticable to construct a feeder from the Fox River to the eastern end of the canal, although there were many who believed it would be cheaper thus to divert the waters of the Fox River than to make the channel of the dimensions originally planned. At last the suggestion was made by Ira Miltimore, who constructed Chicago's first water works, that water might be pumped from the Chicago River into the canal. The idea was endorsed by the Mechanics' Institute and received the favorable consideration of the Canal Commissioners.

It was estimated that it would require \$1,600,000 to complete the canal on the shallow cut plan and there followed the Act of the Legislature of February 21, 1843, by which the Governor was authorized to negotiate a loan for this amount. As security the Governor was empowered to pledge the canal, its tolls, revenues and lands. The loan was to run for six years and bear interest at the rate of 6 per cent. After the loan was subscribed, three "discreet persons" were to be appointed to constitute a Board, to be known as the Board of Trustees of the Illinois and Michigan Canal. One was to be appointed by the Governor of the state, and the two others by the subscribers to the loan. They were to possess all the powers and perform all the duties conferred upon

the Canal Commissioners.

In the following March, Governor Ford, appointed Michael Ryan and Charles Oakley Commissioners to secure the loan. They proceeded to New York, where they obtained subscriptions to a part of the amount required. To secure the balance, they crossed the Atlantic and laid the matter before prominent European capitalists, some of whom were already holders of canal bonds. The latter doubted the ability of the State of Illinois to meet its obligations, and insisted on an investigation of the financial condition of the state as well as that of the canal. They agreed to accept the statement of a committee of Boston men, consisting of William Sturgis, T. W. Ward and Abbott Lawrence. This committee detailed Captain W. H. Swift, a United States engineer, and Ex-Governor John Davis of Massachusetts, to make an examination of the canal. The latter verified the statements made by Commissioners Ryan and Oakley, and reported that the securities for the proposed loan of \$1,600,000 were satis-

factory. The money was then soon subscribed, the contract with the bondholders and the trust deed were executed, and the Trustees were appointed. W. H. Swift and David Leavitt were named by the bondholders to represent them, and Jacob Fry was appointed by the Governor to represent

the state.

Work was resumed on the canal in September, 1845, now wholly under the control of the Trustees, and the business of the canal was directed from their office, first in Lockport, then in Boston, and finally in New York. The Trustees were in control of the canal until 1871, when the deepening of the canal for sanitary purposes was completed. At a meeting of the Trustees on April 20, 1846, the plan for pumping water from the Chicago River into the canal was adopted, and it was also ordered that navigable feeders should be constructed from the Calumet River to the Summit level at or near the outlet of the Sag. The contract for the construction of the Calumet feeder was let in May, 1846, and at the end of the year work on it was in full progress.

Engineer Gooding, in his annual report, covering the operations of the year 1846, gave a careful review of the

changes made, and the reasons therefor. He said:

"The existing law for completing the work having authorized a change of the plan of the canal without diminishing its capacity, and the amount of the funds raised for the purpose rendering it absolutely necessary that a cheaper plan than the one required by the original law should be adopted, my attention was early called to the various plans proposed. "The only important change proposed, and the only one which, in the then advanced stage of the work, could have resulted in much saving of expense, was the raising of the level upon the Summit division. This, it was supposed, could only be effected by introducing a supply of water from other sources, as a substitute for that which would have been derived from Lake Michigan upon the original plan.

The original plan was to supply the canal with water from Lake Michigan, except what was to have been derived from the Desplaines and Du Page Rivers, as far down as Marseilles; and from this point to the western terminus at La Salle, the supply was to be received as at present designated from Fox River through the feeder introduced at Ottawa. There could be no doubt that the

supply of water for the canal below Marseilles would be ample, at least for the purpose of navigation, and consequently the investigation was more particularly directed to the demands and supply above. It had been ascertained that a feeder from the Kankakee River could be introduced upon the Dresden level, which commences at the Du Page River, at lock No. 7, at a moderate expense; and it was known that through this feeder a supply of water, to almost any extent for the canal between lock No. 7 and Marseilles might be drawn. It was also known that a feeder from this river might be introduced on the Joliet level, extending the supply up to dam No. 1, in Joliet village. Upon this same level the waters of the Desplaines and Du Page Rivers could be brought into the canal, whilst upon the Summit it had been proved that the waters of the Fox and Calumet Rivers could be brought through feeders of greater length. It was known, too, that a feeder of some seven miles in length would bring the waters of the Du Page on to the Summit, and that this and a part of the Fox River feeder might be identical.

The obstacles in the way of this work (the construction of the Fox river feeder) led to a more attentive consideration of the plan for raising a supply of water, in This plan part, from Lake Michigan by steam power. had frequently been recommended by various individuals well acquainted with the application of steam power; but so long as it was believed practicable to procure an abundant supply of water through navigable feeders at a reasonable cost and without serious embarrassment, it was not thoroughly investigated. But measures were now taken to obtain the opinions of scientific and practical men upon this subject and to ascertain the probable cost of erecting the necessary machinery. The president of your Board kindly furnished me the communications upon this subject and several gentlemen, eminent for their science and skill; and the result of the information obtained from these and various other sources was such as to induce me to recommend the adoption of this mode of supply, and for the present not to construct the Fox river feeder."

In his annual report, dated December 10, 1847, Engineer Gooding refers to the fact that the canal is still unfinished, attributing the delay to sickness among the employes and to bad weather. Charles Oakley, Trustee for the State, took

exception to these excuses, and, in an appendix to the annual

report of the Trustees, said:

"There has been a culpable delay in the prosecution of the work, and its supposed remote causes are again referred to 'unusual sickness upon the line in the summer and autumn of 1840—high water and the scarcity of hands.' Those pleas have served their turn.

The places of the sick could have been supplied for the time at least, and the scarcity of hands could have been provided for if proper exertions had been made to do so.

The chief engineer now regrets that he is 'compelled to state that the canal is still unfinished,' and were it not for the galvanic shock which I may claim the credit of having administered to him, and which has aroused him from his usual apathy and torpor, he might be 'compelled' to make that statement in another annual report."

This indicates that an extremely bitter feeling had been aroused by the delay in the completion of the canal. When all the circumstances are considered, the delay seems to have been unavoidable. The financial difficulties which nearly wrecked the State itself and temporarily weakened the confidence of capitalists in the canal scheme, the inability of the contractors at times to secure all the laborers needed, the almost continual floods in the Desplaines valley and consequent sickness among employes approaching an epidemic in more than one season, were causes beyond the control of any person. Nevertheless Engineer Gooding was charged with blame so vigorously that his removal was ordered by Governor French on April 18, 1848, but not until the work was practically completed. In the light of all the facts the most severe criticism that can be made upon Mr. Gooding is, that he did not correctly estimate the cost of the canal and permitted the adoption of a plan impossible of completion within the resources of the State. If he had been more correct in his estimates and less hopeful of the future the work might

not have been undertaken at all.

The canal was so nearly completed as to permit a Chicago boat, the General Fry, to pass over the Summit level, from Chicago to Lockport, on April 10, 1848. The formal opening was not announced until April 23, when the General Thornton of La Salle passed through the entire length of the canal, from La Salle to Chicago. This boat reached Chicago on April 23, and the event was celebrated by all the citi-

zens.

Nearly twelve years had elapsed since the work on the canal was inaugurated, a period characterized by discouragement and misfortunate from beginning to end. Chicago and the State of Illinois owe much to it, for it was the cornerstone of their prosperity. The opening of the canal increased the price of lands in the northern part of the State at once, and immigration was given a new impetus. In 1835, the entire population of the State was only 271,727. By 1840 it had reached a total of 476,183, nearly twice the number of five years previous. Chicago really owes its existence to the canal, having been platted in order that town lots might be put upon the market. Its advantageous location was not fully realized until the canal was completed.

Edward B. Talcott, assistant chief engineer, in charge of the Summit division of the canal, was appointed chief engineer on the removal of Mr. Gooding. He took possession of the office on May 3, 1848. In his annual report dated November 30, 1848, he states that all the work on the canal had been completed, with the exception of three unimportant items. The total cost of the canal was \$6,537,254.79. Of this amount \$1,401,192.79 had been paid from the \$1,600,000 loan.

Distances on the Illinois and Michigan canal were fixed as follows:

From Chicago to	
Bridgeport 4	miles.
Summit	44
Desplaines	44
Athens	66
Lockport	44
Joliet	66
DuPage	44
Kankakee Feeder 51	44
Dresden	44
Aus Sable	- 66
Morris 61	- 66
Marseilles 78	"
Ottawa	"
Utica	66
LaSalle	"
Calumet Feeder Head 38	46
Kankakee Feeder Head 55	66
Fox River Feeder Head 89	"

INSTALLMENT OF FIRST PUMPS.

Free navigation of the canal in the early part of the season of 1848 was impeded by a scarcity of water. From Lake Michigan to the Du Page river a distance of 44 miles, the entire supply of water was obtained from the Chicago river by pumping, and by gravity from the Desplaines and Du Page The Calumet feeder, which was expected to supply the Summit level, was not completed until the following year.

From Joliet to the Du Page river, the canal was constructed through a very porous soil. Although the sides and bottom had been lined, it proved to be very leaky. During the months of August and September 5,000 cubic feet of water per minute were discharged into this section of the canal, but the surface level was raised at the rate of only one inch in twenty-

four hours.

The pumping engines proved to be a most important adjunct. The purpose of their construction was to raise water from the river to the Summit level in times of drought. was not supposed that more than one would be needed after the Calumet feeder was completed, but it was thought prudent to provide two. The cost of the engines was \$27,805.16. Buildings, engines and all other machinery cost \$54,156.69. The pump house was located about 250 feet west of the South branch of the Chicago river and near the junction of the canal and the river. It was 166 feet in length and 55 feet wide, and was constructed of brick and stone. One of the engines operated four cast iron cylinder pumps, each 54 inches in diameter and seven feet long. 'Attached to the other was a wheel 32 feet in diameter, with sixteen float boards or buckets seven feet long working in a trough. The water was lifted by these buckets into a flume which communicated with a basin, the latter discharging into the main canal. The combined capacity of the four pumps was 6,300 cubic feet of water per minute, and that of the wheel 6,370 cubic feet per minute.

TRANSFER OF CANAL TO STATE.

The lack of sufficient water in the Illinois river was the burden of complaint in succeeding years as it had been during When the deepening of the canal by the the first decade. city of Chicago was in progress in 1867 the Trustees were prompted to say that whether the canal had a depth of six or eight feet it mattered little so long as its great feeder, the Illinois river, remained unimproved. Up to that time, or at the end of the first twenty years, the average yearly receipts from tolls had been \$189,077. The average yearly cost of re-

pairs and renewals had been \$617 per mile.

The Trustees relinquished control of the canal on April 30, 1871, and on the following day the property was out of pawn and again in the possession of the State. On April 30 the Board of Trustees rendered the following statement of account with the State of Illinois, covering the period from June 26, 1845, the date of the execution of the deed of trust, to April 30, 1871, inclusive:

DERIT

Loan of \$1,600,000 Principal & Int\$ Construction of Canal, Feeders, etc Canal Bonds, Sales, Protection, etc Maintenance and Repairs of Canal and Feeders. Tolls, Collections, Inspection and Salaries General Expenses and Contingencies Premium on Gold for Dividends on Bonds Payable in London Interest and Exchange	1,601,891.90 2,132.25 4,706,482.68 111,003.97 4,405,658.27 3.00 923.27 181,412.07
Total\$1	11,009,507.41
CREDIT.	
Loan of \$1,600,000, Principal and Int\$ Construction of Canal, Feeders, etc	2,153,771,31 1,429,606,21 115,523,23 2,155,622,38 2,195,463,67 1,853,049,61 160,462,71 22,163,32 421,600,82 370,864,42 21,073,80 14,563,52 95,742,41

Total......\$11,009,507.41

GOVERNMENT SURVEYS BY WILSON AND GOODING.

General J. H. Wilson made an examination of the Illinois river in the early part of the year 1867 and suggested the desirability of continuing it to Lake Michigan. He even roughly estimated the cost of a channel seven feet deep from the Mississippi to the lake. The re-survey ordered by Congress on March 2, 1867, was to establish the cost with a greater degree

of accuracy.

The report of Engineers Wilson and Gooding on the new survey was made on December 17, 1867, and was transmitted to Congress by General A. H. Humphreys, chief of engineers, with his concurrence. The engineers stated in their report that they had been guided by the following considerations: The selection of the best route for the purposes proposed, the capacity which should be given to the improvement to adapt it most fully to the requirements, and the accomplishment of the object with the least possible cost consistent with the magnitude and permanency of the improvement.

Three surveying parties were organized and placed under the immediate supervision of Civil Engineer James Worrell, "for the purpose of making a thorough and exhaustive examination of the entire region lying between the southern and western end of Lake Michigan and La Salle on the Illinois river, and also for the purpose of conducting a low water sur-

vey of the river from La Salle to its mouth."

To the first party was assigned the duty of surveying the line of the canal from Chicago to La Salle, the Desplaines and Illinois rivers, and all the alternate lines which had at any time been spoken of, including that of Mud Lake. The second was directed to survey the Calumet and Kankakee rivers and the country lying between the Kankakee river and Lake Michigan, as well as the Fox river and a section of the lower Illinois. To the third party was given the assignment of a careful hydrographic survey of the bed of the Illinois river from La Salle to Grafton, paying particular attention to the location, cause, character and extent of different sandbars and obstructions to navigation during low water; also, to gauging the river and its tributaries and making examinations of the various points likely to be selected as sites for locks and dams.

The engineers concluded that the location of the existing canal from Bridgeport to the valley of the Desplaines could not be advantageously or economically changed. It was the best, cheapest and most direct route, they said, that could be

found. More than enough work had been done on it to counter-balance the natural but not superior advantages of the slightly lower but more tortuous route by way of Mud Lake. The Calumet river and Saganaska creek route, along what was known as the Calumet feeder, would cost a great deal more than either of the others since it was longer and ended at a point where there was neither a natural nor an artificial harbor, and where it would be impossible to construct one which would answer the purposes of commerce and the national defense. It was found to be impracticable at any cost to use any part of the Kankakee river as a part of the system of

navigation.

"We have therefore to recommend," Messrs. Wilson and Gooding said, "that the improvement in question shall be made by widening and deepening the present canal from Bridgeport to the head of Lake Joliet with the exception of a section of 111 miles between Summit and the Sag, where it will be cheaper to excavate an independent canal. From Lake Joliet to Marseilles the line should follow to the bed of the river, the necessary depth being secured by a system of locks and dams. At Marseilles it will be necessary to construct a piece of independent canal in order to pass the grand rapids of the Illinois, striking the river again at or above Ottawa, as may be found to be the most economical. From the latter point to the mouth of the river the necessary navigation should be secured by a system of dams and locks. It is also recommended that all the canal on this line should have a width of not less than 160 feet and a navigable depth of six feet, corresponding to the lowest known level of the water in Lake Michigan, and an average depth of between seven and eight feet; that the present Summit shall be cut down so as to secure this depth in the canal from the inexhaustible reservoir of Lake Michigan."

GOVERNMENT SURVEY OF BENYUARD.

On August 11, 1888, Congress appropriated \$200,000 for the improvement of the Illinois river. The Act making the appropriation also contemplated a survey for a serviceable waterway from Lake Michigan to the Mississippi river, as shown by the following clause:

"And for the purpose of securing a continuous navigable waterway between Lake Michigan and the Mississippi river, having capacity and facilities adequate for the passage of the largest Mississippi river steamboats, and of naval vessels suitable for defense in time of war, the secretary of war is authorized and directed to cause to be made the proper surveys, plans and estimates for a channel improvement and locks and dams in the bed of the Illinois and Desplaines rivers from La Salle to Lockport, so as to provide a navigable waterway, not less than 160 feet wide, and not less than fourteen feet deep, and to have surveyed and located a channel from Lockport to Lake Michigan, at or near the city of Chicago, such channel to be suitable for the purposes aforesaid."

Captain W. L. Marshall, who succeeded Major Benyuard, was then in charge of the river and harbor work in this vicinity. In a letter of instructions from General Thomas L. Casey, chief of engineers, Captain Marshall was directed, whatever line might be found most advantageous and economical to the United States, to submit plans and estimates for a route terminating within the limits of Chicago, sufficiently distinct and in detail to enable the chief of engineers to form a definite and conclusive opinion as to its merits from the standpoint of the commercial and sanitary interests of Chi-

cago.

A survey party was organized and put in the field October 1, 1888, under the charge of Assistant Engineer L. L. Wheeler. By December 1, 1888, the field work relating to the superficial survey of the several practicable routes from Lake Michigan at or near Chicago by way of the Chicago Divide and the Desplaines river valley as far as Joliet were practically completed. The survey made by Major Benyuard and Engineer Wisner in 1883 from Joliet to La Salle was adopted, so far as it was sufficient for the purpose, to avoid unnecessary complication of work and expense.

In his exhaustive report Captain Marshall said there were two practicable routes across the Chicago Divide. One was by way of the Chicago river, the South branch and the Illinois and Michigan canal, or Mud Lake and the Ogden ditch, to the Desplaines river near Summit, about twelve miles from the city hall of Chicago and about eight miles from Bridge-

port; thence by way of the Desplaines river valley.

The second route was by way of the Calumet and Little Calumet rivers to Blue Island, thence westward along the old Calumet feeder route to the Desplaines river at Sag, where the two routes became common. There was a practicable de-

tour from the second route which left the old feeder line a short distance west of Blue Island and continued in a more direct line south of Lane's Island, uniting again with the

feeder line about five miles east of Sag bridge.

Captain Marshall did not favor a deep cut across the Chicago Divide at the expense of the United States and for the sanitary benefit in part of the city of Chicago. He sought to secure a modification of his instructions limiting the survey under his direction to a channel of smaller dimensions. addressed a communication to General Casey on May 1, 1889, in which he stated that local necessities, for sanitary reasons, demanded a large discharge from Lake Michigan into the Illinois river. Navigation interests, he said, not only did not demand an increased discharge into the Illinois river, but such discharge would result in a positive injury to navigation. A navigable channel demanded no slope to the costly cut through the Chicago Divide, but local sanitary necessities required a slope of not less than four inches to the mile and a cut deeper by about seven to eleven feet in rock and three to seven feet in earth. He asked the department whether it desired that the estimates demanded by Congress should be rendered on the basis of the requirements of navigation, or whether the local drainage problem should also be considered.

Captain Marshall was asked in turn by the department for suggestions. In his reply he appeared to regret that the Act of Cengress did not allow the capacity of the channel to be determined by the consideration of the size and draught of Mississippi river steamboats that could reach the mouth of the Illinois river. He desired to make the estimates required by law for a 14-foot channel, and for an 8-foot channel also, as required for steamers navigating the western rivers, leaving such modifications of the channel as might be required by local sanitary necessities to be attended to by local authori-

ties.

General O. M. Poe, engineer of the Northwest division, endorsed the communication of Captain Marshall with this remark:

"It does not appear that the project for a fourteenfoot channel must necessarily cover the whole distance from Lake Michigan to the Mississippi river, but may be limited to the portion between La Salle and Lockport. The only requirement imposed by the law for the remainder is that it shall provide for a channel having capacity and facilities adequate 'for the passage of the largest

Mississippi river steamboats and of naval vessels suitable for defense in time of war."

The communication was forwarded to General Casey who

issued this order:

"Surveys, plans and estimates for a 14-foot channel as required by law, and for the 8-foot channel required by western river boats, should be made in the interest of navigation. Modifications required to adapt to local wants the navigable channels thus surveyed should be left

to local authorities."

In his suggestions Captain Marshall seems to have been guided by a predetermination that a channel for navigable purposes would never be extended to the Chicago river through the upper Desplaines valley. In fact, he said in his report of the surveys, in direct opposition to the views of Government engineers who had preceded him, that the terminal facilities at the mouth of the Calumet river, "the ample landlocked natural basins (needing only deepening by dredging) for the construction of a great development of wharves and docks in public waters of the United States, scarcely excelled anywhere on the Great Lakes," pointed irresistibly to the Calumet region as the proper terminus of a great waterway between the Great Lakes and the Mississippi river. Under the direction of Captain Marshall large sums of money have since been spent by the Government in creating a channel in the bed of the Calumet river nearly a mile in length, 250 feet wide and 16 feet deep.

Acting under the orders received from his chief, Captain Marshall made surveys and estimates for two channels, one fourteen feet deep and the other eight. In his report, preliminary to an explanation of his plans, he analyzed the navigation of the Mississippi river and such of its tributaries as would be served by the proposed waterway. In the Desplaines and Illinois rivers the practical depth of navigation after the construction of the smaller channel, would vary with the stage of the rivers. From Joliet to La Salle there would be a navigable channel varying in depth from eight feet, when the discharge of the river was at a minimum, to ten to six teen feet at mid-stages. Below La Salle to the Mississippi river there would be a depth of navigation varying from seven feet at extreme low water, to twelve feet at mid-stage and eighteen feet or more at floods. The minimum low water depths sought on the Illinois river were greater than those proposed for that portion of the Mississippi river with which

it immediately connected.

The 14-foot channel would accommodate with increased facility all large vessels that could reach its terminus at La. Salle through the channel of the Mississippi river. But vessels on the Mississippi that could not be accommodated by the 8-foot channel at extreme low water would not be accommodated by the 14-foot channel 160 feet wide, although a channel fourteen feet in depth at extreme low water in Lake Michigan to eighteen feet at high water across the Chicago Divide, could be navigated by large boats, if there were still water or a very moderate current, with greater facility than a still water

channel eight to twelve feet in depth.

This was the best argument for such a channel, based upon the present or probable future navigation of the Mississippi river and its tributaries, Captain Marshall said, but it was not a public necessity. No greater depth of channel than nine feet at extreme low water in Lake Michigan across the Chicago Divide seemed to him necessary for navigation by vessels similar to the largest Mississippi river craft that could neither use it nor reach it. But a channel of much greater capacity discharging a large volume of water into the Desplaines and Illinois rivers not necessary for navigation in a canalized river, as this must necessarily be, was made locally urgent by the sanitary necessities of the city of Chicago for drainage and an uncontaminated water supply. These necessities ended when the Chicago Divide was passed and the discharge turned into the channels of the rivers.

Beyond the Chicago Divide there was no apparent necessity then nor likely to exist in the near future, either national or local, for a channel of materially greater capacity than the minimum estimated for between the Mississippi river and the Great Lakes, although every increase in depth and width up to a certain limit throughout the artificial channel would increase the facilities for navigation, probably without affecting the character, size or draught of the boats that would use it

as a through route of transportation.

THE Two ROUTES.

The two routes for which estimates were made by Captain Marshall, one by way of the Chicago river and the other by way of the Calumet river and the Sag, united at the Sag bridge, about seventeen miles respectively from Bridgeport and Blue Island. From Sag to La Salle they coincided. The Chicago route followed the Chicago river from its mouth by way of the South branch to a point near Bridgeport, the West

fork of the South branch and the Ogden ditch to Summit, thence parallel with the Illinois and Michigan canal on lower ground for about three miles, and entered the bed of the Desplaines river. Cutting off bends it followed the Desplaines river to the Sag bridge. This route was preferred to the line of the Illinois and Michigan canal for these reasons:

It occupied lower ground, and the probable amount of excavation was less, since the earth excavated from the old

canal remained as spoil banks to be removed.

The old canal was parallel by a railroad on either side, and there was not sufficient room for the enlargement of the canal without condemning the railroad right of way and removing one or both tracks.

The present canal was the property of the State of Illinois, and the conditions of transfer had not been accepted by the United States. These conditions were such that their acceptance would involve greater cost than a new right of way.

The Illinois and Michigan canal was the main sewer of the city of Chicago, as well as a commercial highway, and could not well be enlarged without seriously interfering with its uses, or at increased cost of work from delays due to traffic on the canal.

As a means of transportation and drainage it was of advantage in the prosecution of the work parallel with it that it should be maintained in a serviceable condition during the construction of the larger canal.

The new route avoided excavation in solid rock for several miles, between Willow Springs and Lemont, which was found

in the bed of the old canal.

The proposed Sag, or Calumet river route, followed the Calumet river from Lake Michigan to One Hundred and Tenth street, thence by way of a cut-off through Lake Calumet to its southwestern shore, thence by another cut-off to the Little Calumet river, thence to Blue Island, and nearly due west along the line of the old Calumet feeder north of Lane's Island to the junction of the two routes at Sag bridge. The line through Calumet lake was more expensive than by way of the rivers to Blue Island, but was preferred because it was five miles shorter, and because Lake Calumet afforded greater facilities for the construction of an "unobstructed land-locked harbor of great proportions, affording ample room for a turning basin and great development of docks and wharves suitable for an extensive commerce and easy transfer between lake and river steamers." The route north of Lane's Island,

although about two miles longer than the direct line south of the island, was preferred because the material to the south for several miles was a soft muck, peat and vegetable matter, in which it would be extremely difficult and expensive to maintain a definite channel.

BRIDGEPORT PUMPING WORKS.

When it was found necessary to abandon the deep cut in the construction of the Illinois and Michigan canal it was suggested that pumping works be erected at the head of the canal to supply it with water. The suggestion met with approval, and the pumping works were built and put in operation when the canal was opeend in the spring of 1848. Although constructed for the sole purpose of supplying the canal with water to make it navigable, the city soon discovered that they were performing a very useful duty in cleansing the Chicago river. This led to an arrangement with the Canal Commissioners in 1865, by which the latter agreed to pump water from the river into the canal at certain times for the relief of the city from the serious annoyances of a badly contaminated river.

A heavy rainfall in that year kept the river in a comparatively clean condition. In 1866 the pumps were operated 62 days; in 1867, 150 days; in 1868, 73 days and in 1869, 100 days. The amount of water raised by them in 1869 is estimated to have been 10,000 cubic feet per minute. The increase in the demands upon the pumps was due to a diminished rainfall, a lowering of the lake level and a greater pollution of the South branch of the river. The increasing business of the packing houses at Bridgeport was mainly responsible for the pollution. In 1860, 306,428 head of cattle and hogs were slaughtered, but in 1863 the number had increased to 1,029,948. The growth of the business and the consequent defilement of the river continued from year to year. Soon after the completion of the deep cut in the canal in 1871, the packing houses were removed from Bridgeport to the present location at the Stock Yards. The liquid refuse was then discharged into the South fork of the South branch, which soon became indescribably foul. This fork of the river, now a stagnant pond, the sickening contents of which overflowed into the South branch when it became full, has since remained the one plague spot within the city. In 1863 an epidemic of erysipelas occurred along the South branch and was traced by physicians to the decaying animal matter in the river. This was one of the immediate causes of the appointment of the Commission in 1865 to de-

vise a plan to cleanse the river. .

It was not many years before the citizens deplored the fate of the pumps. A constant current was not maintained through the river from the lake, owing to fluctuations in the lake level. the direction of the wind, and other causes. The action of a southwest wind on the water of the Chicago harbor at one time resulted in lowering the water in the canal at Lockport, 27 miles away, fifteen inches. The rainfall had much to do with the amount of water which flowed from the river into the canal. In 1879 the current of the river was lakeward for thirty days, and for ten days there was no perceptible current either way. In 1873 for sixteen consecutive days, it is said that the average amount of water passing through the canal at Bridgeport was 33,000 cubic feet per minute. In 1879 the amount was estimated to be only 17,000 cubic feet at any time and only 10,000 cubic feet in the winter when the canal was frozen over.

Dr. John H. Rauch, secretary of the State Board of Health, took up the question of the contamination of the water of the Illinois and Michigan canal in 1878 and 1879 in the interest of the people living in the valley of the Desplaines, they having begun to make serious complaint. Under his direction daily observations were made by Samuel M. Thorp, locktender at Joliet, to determine the daily stage of water in the canal, the offensiveness of the odor arising from it, the general force and direction of the winds, the temperature and the degree of contamination of the water. Mr. Thorp's observations were begun on October 14, 1877, and continued to the end of November, 1878. During the winter of 1877 and 1878 an increase in the amount of sewage and the degree of the odor arising from it were observed whenever the water at the dam was low. As the amount of water increased the offense from the sewage diminished. During the period of Mr. Thorp's observations there were 249 days in which the water was filthy, and only 14 in which it was clear. On 117 days the odor was marked, on 116 days it was slight, and on 140 days there was no odor. On 211 days the water was low, and on 90 days it was high. These observations demonstrated to Dr. Rauch that a low stage of water was always attended by increased contamination and by an increase in the offensive odor and that the condition of the water was invariably in a marked degree even by an increase in the depth of the water by an inch or two. September 30, 1878, following a low stage of water, the observer noted that all the fish in the river were killed, and on October 15, persons passing over the bridge were nauseated by the offensive odor. From the close of Mr. Thorp's observations until February, 1879, the odor escaping from the river at Joliet was so offensive that public meetings were held and committees appointed to visit Chicago and demand relief. Dr. Rauch reports that during the fourteen months of Mr. Thorp's observations there was almost continued low water. Only once did the water rise fifteen inches above the low water mark and the average height above it did not exceed two inches. This indicated that the amount of water passing over the dam was diminishing, due to the lower-

ing of the lake level 35 miles away.

Dr. Rauch concluded that the only remedy for the offensive condition of the canal and the Desplaines river would be found in an increased and constant flow of water from the lake into the canal. He suggested to the State Board of Health that it recommend to the city the rebuilding of the pumping works with the least possible delay. "This will be the first time," he said, "that the board has made a recommendation to the city of Chicago in relation to its sanitary affairs. There is another view of the case to which the attention of the municipal authorities of Chicago should be called, which is that the city has no right unnecessarily to injure the material and sanitary interests of any other part of the State. The community of interests which exists between the citizens of Chicago and the inhabitants of the country lying along the canal and river, forbids the injury of either by the other. It is but just to state that the plans heretofore adopted for the sewerage and drainage of the city of Chicago have been made with a view to such change as the future might require. The deepening of the canal, which was begun in 1865, was not completed until 1871, so that the relief afforded by that measure was delayed six years from the time when its necessity was recognized. The pumping works can be rebuilt in ninety days. My reasons for recommending this course are that the works will furnish almost immediate relief without great expense and without interfering with the project for a ship canal, or with any more permanent plan which may become necessary for disposing of Chicago sewage."

The amount of water needed to cleanse the canal, Dr. Rauch said, was from 60,000 to 100,000 cubic feet per minute.

William Thomas, general superintendent of the Board of Canal Commissioners, at the close of the year 1879, called the attention of the Canal Commissioners to the condition of the Summit level. When the water was let into the deep cut the lake was more than three feet higher than it was in 1879. Navigation had been seriously interfered with. Either the bottom of the canal must be lowered throughout the entire length of the canal, he said, or more water must be supplied at Bridgeport. In his judgment it was a great mistake that the old hydraulic works at Bridgeport had not been preserved. With those works restored the water in the canal could be kept nearly as clean as that in the lake itself, and the navigation of the Summit level restored to its normal condition at an expense not to exceed \$75 a day. He thought the city of Chicago and the Canal Board should at once take steps to accomplish this purpose.

The recommendations of Dr. Rauch, fortified by the opinions of Mr. Thomas, were concurred in by the State Board of Health, and a copy of the secretary's report was transmitted to the Mayor and Common Council of the City of Chicago. The subject was earnestly discussed by the press, the Chicago Citizens' Association and the Engineers' Club. There were conferences between the State and city authorities and a convention was held at Ottawa to further the interests of a ship canal. The result was that the Common Council appropriated \$100,000 on March 29, 1880, for the construction of pumping works at the head of the Illinois and Michigan canal.

During the year 1880 the condition of the river continued to grow worse. In June Dr. Rauch made an examination of the Chicago river and found it more foul and offensive than it had been since the deep cut was completed in 1871. In the main river the current was toward the lake indicating little change in the level of the lake. At Van Buren street the water was almost stagnant. At Eighteenth street there was no current, and there was none at Halsted street for the first time within the secretary's recollection.

On July 19, 1880, a petition from the citizens of the city of Johet was sent to the Canal Commissioners asking the privilege of digging ditches, without cost of the board, between the canal and the Desplaines river with a view of the purification of the waters of the canal. The petition follows:

"Gentlemen:—We, the undersigned, citizens of Joliet, Will county, and State of Illinois, would most respectfully petition your Honorable Body (for the reasons heremafter mentioned) for the privilege of digging, constructing and making such ditches, flumes, races and head gates, without cost to your Board, between the Illinois and Michigan Canal and the Desplaines river, and along the line of the same from Lockport to Bridgeport, as will allow a sufficient quantity of water to pass from said river into said canal to feed the same, or so much of it as said

river may be able to furnish.

Your petitioners would most respectfully represent that for very much of the time during the last nine years, they have suffered to an extent beyond description from what they had supposed a nuisance caused by the city of Chicago cutting down the Summit Level of the Illinois and Michigan Canal, and turning its sewage matter, together with all other nastiness, from thence through the Chicago river into the canal. But having recently sent a committee of our business men to confer with the Mayor of Chicago, with reference to the proposed pumping works at Bridgeport, and, however strange it may appear to others, having learned from his Honor that the water in the Chicago river was pure and clean enough for bathing and toilet purposes and what was still stranger, that the nuisance complained of was not caused by the city of Chicago, but by your Honorable Board, that committee was instructed by his Honor to stir us up, to assist him in compelling your Honorable Board to abate the nuisance. And through his Honor, our committee was further informed that on account of the Fullerton avenue conduit and its pumping properties, the city of Chicago did not need the Bridgeport pumping works nor the Illinois and Michigan Canal itself; that the water that passed into the canal from the Chicago river was for the benefit of the canal and not for the benefit of the city.

In view of all these facts (and facts they must be, or surely Mayor Harrison would not so advise us), we come to you and most earnestly pray your Honorable Body to not only allow us to make the openings mentioned above, but also that your Board would avail itself of its right to restore the dam at the south end of what was once known as Lane's Lake, or head of Rock Creek, four miles northwest of Blue Island, and turn its waters back into the old Calumet feeder, and through it into the Illinois and Michigan Canal. By the assistance of these two sources of supply we are advised the water from the Chicago river

can be entirely prevented from entering the canal for about eight months of the year, and in part for a longer period of the year, so that to a very great extent we shall be relieved from what is now an intolerable nuisance. Your petitioners would most respectfully urge your Honorable Body to give the subject that careful consideration which its importance demands, at the next monthly meeting of your Board, August 12th, next, to the end that we may get whatever relief is possible during this season.

We have no doubt ample means can be obtained to do this work from parties who own lands at the Summit, that are now nearly worthless, and which by means of the drainage will become very valuable. Each sluice or race to have ample gates to be closed against floods, and for a brief time at the beginning of winter to allow the

ice-fields south of Summit to fill with water.

All of which is respectfully submitted."

At the close of the year 1880 the Canal Commissioners reported that the sewage of the city of Chicago in passing through the canal caused such an offensive smell as to become an almost intolerable nuisance to the citizens of Joliet

and other towns along the line of the canal.

The State Legislature was now induced to use its influence and power in compelling the city of Chicago to divert its sewage from the Desplaines and Illinois valleys or dilute it with a larger discharge of water from the lake. A joint resolution was introduced in the senate by Senator Munn of Will county,

which made these alarming statements:

'The foulness of the water annually causes the death of millions of fish in the Desplaines and Illinois rivers, that float to the shores and decay. The sewage in an entirely undecomposed and putrid mass is carried by the current of the canal into the Desplaines river and thence into the Illinois river, rendering the air at all points along its passage so impure and foul as to be exceedingly offensive, and taking with it germs of disease of all kinds prevalent in the city of Chicago, thus spreading them broadcast through the entire Desplaines and Illinois river valleys, causing thereby much illness as well as poisoning the blood and debilitating the systems of 200,000 people. Careful investigation leads the people to fear that an epidemic may spread over said section of the state of Illinois from the causes above stated. In addition to the above distress there has been a great loss to prop-

erty, business industries and to the communities by reason of the causes herein mentioned. Prior to the deepening of the Illinois and Michigan canal the water necessary for all purposes of navigating the canal and propelling machinery was obtained from the Desplaines river and the Calumet feeder through Lane's lake. The bed of the Desplaines river at Summit and thence westward along the line of and adjacent to the canal is at a low stage of water eight above the surface level of the canal and will average a supply of water sufficient for all canal and power purposes during the seasons of navigation. The supplying of the canal from these sources will so dilute and weaken the sewage of the city of Chicago as greatly to relieve it of its foulness and stench, to the great delight, relief and health of the people near to and bordering upon the line of the canal, the Desplaines and Illinois rivers.'

Following this preamble was a resolution directing the Canal Commissioners to cause sluiceways of sufficient capacity, with the proper guard gates, to be opened from the Desplaines river to the canal at or near Summit in Cook county, and at or near Lemont in Cook county, and also to construct a dam across the former Calumet feeder at such suitable point as would cause the water from Lane's Lake to flow into the canal. The commissioners were required to commence this

work immediately, the cost not to exceed \$10,000.

This bold attempt to coerce Chicago into disposing of its sewage by some other method than discharging it into the Illinois and Michigan canal met with determined opposition on the part of Chicago, and several provisos were added to the resolution which gave the city the benefit of an alternative. The provisos authorized the Canal Commissioners to confer with the Mayor of the city of Chicago, or authorities of the city, concerning an increased flow of water into the canal. If the city should proceed without delay to cause a flow into the canal from the Chicago river sufficient to dilute and purify the waters and thus remedy the evils complained of, such flow to be not less than 60,000 cubic feet per minute, including the ordinary flow into the canal from the river, the work to be accomplished by the 1st day of September, 1881, the Commissioners were directed to accept it in lieu of obtaining a supply from the other sources named. The Commissioners were required to take care of 60,000 cubic feet of water per minute, but the State was not to be committed to a system of permanent drainage of Chicago sewage through either the canal or the Desplaines or Illinois rivers, the State reserving the right to require the city of Chicago in future years to take care of its sewage through other channels. The city was also required to maintain and manage the pumping works, subject to the direction of the canal commissioners, relative to the amount of water to be received into the canal. The resolution, as amended, was adopted by the Senate on

May 18, 1381, and by the house on the following day.

At the time of the tests the lake level was at an average high stage, and the conditions were favorable to the pumps. Both river and canal were kept in a comparatively inoffensive condition for two years. In 1886 the average mean level of the lake below datum was 2.64 feet. In the following year it dropped to 1.96 and continued to fall until it reached 0.05 feet above datum in 1891. With the lowering of the lake levels the pumps were required to raise the water at the head of the canal through a greater distance, and the result was a less amount pumped. The required 60,000 cubic feet per minute was reduced to an average of 37,771 cubic feet during the year 1891. With little more than half the required amount of water pumped from the river, and the sewage discharged into the river greatly increased because of the rapid growth of the city, the river and the canal again became very foul and offensive. But the city of Chicago had complied with the requirements of the law of 1881, and the Canal Commissioners did not make the cuttings from the Desplaines and Calumet rivers which the people of the valley demanded. Had they done so the outlet for Chicago sewage toward the interior of the State and the Mississippi river would have been cut off, and Chicago would have suffered immeasurably. The resulting contamination of the city's water supply would have depopulated the city.

OGDEN WENTWORTH CANAL.

Before the deepening of the Illinois and Michigan canal in 1871 the low and swampy land lying east of Summit and north of the canal was covered with water during the greater portion of the year. This territory included several hundred acres and constituted what was known as Mud lake. It extended eastward from Summit about three miles and northward nearly to the West fork of the South branch of the Chicago river. Its surface was below the level of the water in the canal, but several feet higher than that of the Chicago river. The latter condition suggested to the owners of the

swamp property the feasibility of reclaiming it by dredging an outlet to the Chicago river. It was also proposed to improve other low-lying lands in the vicinity in the same manner. Ditches were dug in both directions from the East fork of the South branch, some of them connecting with Mud lake. But the latter were not effective until the completion of the deep cut in the canal, because the lake was filled with seepage from the lake as rapidly as it was drained through the ditches.

FULLERTON AVENUE CONDUIT.

In the original plans of the city's sewerage system, it was foreseen that the Chicago river and its branches would sooner or later become sources of great annoyance unless artificial means were taken to maintain a circulation through it. The main river and the South branch depended to a certain extent upon the Illinois and Michigan canal. The North branch had no such auxiliary. City Engineer Chesbrough, who planned the city's sewers, hoped, as he said in his report for the year ending March 31, 1870, that by arranging the system so that but very little filth would be discharged into the North branch it might be many years before it would be necessary to construct any expensive works to purify it.

But this branch of the river became foul much earlier than was expected. Up to the year 1870 less than 5 per cent. of the sewage of the city is said to have been discharged into the North branch, but it received the waste from distilleries and tanneries erected along its banks. It became so offensive that the State Board of Health was called upon to enforce the State law against the maintenance of nuisances. The Board's action brought some relief, but the condition became so serious that the Board of Public Works was of the opinion in 1870 that it was not wise nor safe to postpone further "entering upon some efficient plan for keeping clean

the North branch."

City Engineer Chesbrough recommended in that year that a covered canal, or conduit, be constructed along Fullerton avenue between the North branch and the lake, A summary of his discussion of this subject is given in Chapter VI. The Board of Public Works agreed that "for flushing out the river but one of the many schemes proposed seems to them to promise to be effectual and worthy of adoption, that is, the construction of a canal, open or covered, between the lake and the North branch, through which the water shall be forced

by mechanical means, either into the river or into the lake, as

shall at the time be necessary."

In September, 1872, the artesion well scheme for flushing the North branch was proposed and rejected. Still another year was spent in a discussion of other possible means of purifying the increasingly offensive stream. It was finally decided to construct the conduit, and proposals were advertised for three times. The contract was ultimately awarded to Geo. F. Norris & Co., under proposals opened on March 31, 1874, at \$343,284. The work was to be completed on July 1, 1875, the conduit was to be circular in shape, twelve feet in interior diameter, the invert at a grade of thirteen feet below datum, and extend from the North branch of the Chicago

river along Fullerton avenue to Lake Michigan.

Excavation was begun about the first of June, 1874, at Ashland and Fullerton avenues. The work was carried on in both directions until December 8, when it was discontinued. About 4,000 feet had been constructed. The contractors found, as they claimed, that the character of the work had been misrepresented, and that their price was too low. The Board of Public Works resisted their claim for an increase of price, but a settlement was effected on June 14, 1875, and the contractors were released. New proposals were received on July 26, and the contract for the completion of the work was awarded to FitzSimons & Connell. The contractors were given the option of doing the work in open excavation or by tunneling at a lower grade. This contract was concluded on September 13, and work was resumed on October 28. Shafts were sunk at the lake shore, Larrabee street and at Sheffield West of Racine avenue the excavation was an open avenue. cut; east of that point, a tunnel.

The conduit was completed and the machinery put in operation on January 9, 1880. It was a brick tunnel twelve feet in diameter and 11,898 feet in length. The bottom of the tunnel from the river to Racine avenue, a distance of 4,270 feet was level, and thirteen feet below datum. A short distance east of Racine avenue it dropped to a grade beginning at a depth of 27\(^2\) feet below datum. It was continued in a series of descending grades to the lake shore shaft where it was 54\(^1\) feet below datum. From this point to the lake shaft, 1,000 feet in length, the conduit was level. The change in the grade

was made for convenience in excavation.

When the conduit was opened the pumps were operated to draw water from the lake into the river. Other circumstances favored the cleansing of the North branch. There was a heavy rainfall and long continued high winds from the northeast, which helped to drive the water from the main river up the South branch, thus aiding the Bridgeport pumps to do their work. So long as the pumping from the lake into the river through the Fullerton avenue conduit was continued the North branch was kept in a cleanly condition, and the conduit was pronounced a success. The condition of the main river and its branches in the year 1880, with other facts relating to the drainage and sewerage of the city, is shown by the following tabular statement:

CONDITION OF THE RIVER AND EXTENT OF THE SEWERAGE OF THE CITY IN 1880.

NAME	Area of surface in acres draining into each branch		No. sewers dis- charging into nal openings in each branch square feet.	Condition of the water in each divi- sion of the river.	Relative density of population on each of the given area.
North Branch	1,988.98	19	229.53	From rolling mill north comparatively 2/3 densely, 1/3 pure; from same point south highly sparsely sparsely	2/3 densely, 1/3 sparsely
Main River	808.08	16	122.47	discolored, with little odor. Nearly free from deleterious matter, little or no odor.	Densely settled.
South Branch	3,364.00	88	460.05	with very little odor	7/8 densely, 1/8 sparsely settled
West Fork of South Branch	581.73	69	56.94	No perceptible odor, water nearly pure. Sparsely settled	Sparsely settled.
South Fork of South Branch	354.45	10	52.82	Extremely foul, water charged with decomposing animal and vegetable Sparsely matter, odor very offensive.	Sparsely settled.
	7,097.33	06	921.81		

That portion of the South division of the city which drains directly into the lake contained 1,270.43 acres, making a total area of 8,368 acres covered by the sewer system of the city in 1880, a little more than 36 per cent. of the entire area of

the city.

The conduit pumps were operated irregularly during the first year, and by the aid of the rains and winds the North branch was kept in a comparatively inoffensive condition. In the following year the pumping was mainly from the river into the lake. Occasionally when the current of the river north of the pumping works was so strong that the pumps had little effect upon it the pumps were reversed. When the current was toward the lake the offense of the North branch was transferred to the lake shore, in a less degree, and the city's water supply was often contaminated by distillery refuse and sewage.

New wheels eight feet in diameter were put in during May and June, 1882, increasing the power and efficiency of the works. City Engineer Artingstall made these statements in

his report covering that year:

"The greater part of the year the water has been discharged from the river into the lake with good results, maintaining during such times the North branch and the main river in an excellent condition, free from offensive odors and the water comparatively clear. Twice during the year the experiment was made, for extended periods, of pumping from the lake into the river. During both times the water in the main branch became foul and very offensive."

The people differed from Mr. Artingstall as to the effects of the water pumped from the North branch into the lake and vice versa, and such protests were made against pumping into the lake that it was done only occasionally. It was entirely discontinued in 1885. While the North branch has been greatly improved by the conduit pumps, it has been very offensive in recent years due to the increase of the sewage discharge into it and the number of factories and other refuse producing operations on its banks.

The pumps have fallen considerably short of their original requirements, the average amount of water per day during the year 1891 being 15,000,000 cubic feet. This was about 10,416 cubic feet per minute. The conduit has a capacity of

about 24,000 cubic feet per minute.

CITIZENS' ASSOCIATION.

Much was done by the Citizens' Association of Chicago between the years 1880 and 1889 in creating and fostering a public sentiment which demanded better drainage for the city. Several expert examinations were made by the association and its reports were given to the people through the daily papers and printed pamphlets. These investigations and the resulting discussions led to the more exact and complete investigation by the Drainage Commission under the authority of the municipality. Although the suggestions of the association were not always practical, they kept the people thinking, a very

useful preliminary to public legislation.

The association referred the subject of main drainage for the City of Chicago to a committee in the year 1880 with a request that it recommend some system for the disposal of the sewage of the city which should be adequate for present and future needs. The committee consisted of John B. Sherman, George C. Morgan and S. B. Reed. In the course of its investigations the committee employed A. J. Mathewson, a civil engineer of Joliet, to make surveys and estimates. The results of the committee's inquiries were given to the association in a report made in December, 1880, which was endorsed by the association.

Objections to these plans were found in the original and continually increasing expense and because they required a discharge of all or a portion of the sewage into the lake.

"Our objections to any plan," the committee said,
which suggests the discharge of sewage or impure matter into the lake, where they could in any event contaminate the water supply, are so fixed that part of the recommendation in the plan we shall hereafter propose is that a radical change in the whole system of sewerage in the North and South divisions shall be inaugurated by which all sewers shall empty into the river. Although we have given careful consideration to all plans laid before us we make no reference to any except those mentioned above, which propose the use of the lake for the ultimate disposition of the sewage."

The committee thought it proper to remark in this connection that the filthy water discharged from the Fullerton avenue conduit, when it was operated in the direction of the lake, could be traced for a long distance in the direction of the water works crib. To attempt to get the water supply from a more distant point, either out in the lake or toward the north

would be only a partial remedy. Besides, the cost would be more than that of a permanent and wholly satisfactory plan for the disposal of the sewage. It was suggested to the committee that the lock and dams in the Illinois and Michigan canal might be removed when the water from the Chicago river would flow freely through it. To this the answer was given that the usefulness of the canal commercially would be destroyed, private interests seriously affected and a deepening of the canal necessitated.

The considerations of the committee were finally narrowed down to two popositions. One of these involved the construction of a ship canal, which seemed to have the sanction of

public opinion.

"We have given a large share of our attention to this scheme," the committee said, "with little knowledge of the methods of sewage purification, and although we are unanimously and cordially in favor of a ship canal as such, we cannot give it the sanction of our favorable opinion as a drain. At such it would be liable to all the objections now urged against the present canal, as to its annoyance of the inhabitants along its banks for the reason that any current which would move the water with sufficient velocity to prevent the deposit of filth would impair its usefulness for commercial purposes, it having been ascertained that no current greater than half a mile per hour is tolerable in slack water navigation. The project for such a canal is embarrassed also with many considerations of a political nature, which we do not deem it within our province to consider, preferring to present the other plan, which can be carried out within a reasonable time at a very moderate cost, and which is wholly within the scope of the pecuniary means of those for whose benefit it will have been constructed, and will, it is believed, be wholly devoid of offense to any locality or people."

The plan as revised and approved by the committee pro-

vided for the construction of a canal, or

"New river," which is described by Engineer Mathewson, as starting "from the mouth of the Regula, or Mud Lake fork of the South branch of the Chicago river, running off west and through said lake toward the Desplain's river north of Summit, and then curving round to the left, keeping away to the left, and passing along in a southwest direction between the canal and the river, past the ice houses and between said house and the river to Mount Forest, Willow Springs, Sag Bridge station and Lemont to the Romeo bend of the canal, Norton's tailrace at Lockport, and to a point opposite lock No. 1 at Lockport; thence to a point at the head of the pond of dam No. 1, Joliet, a few hundred feet northwest of lock No. 4 of the Illinois and Michigan canal, a distance of not far from

314 miles."

The committee thought this plan sufficient for the drainage of Chicago for all time to come. To complete it the sewers discharging into the lake would need to be reversed and made to discharge into the Chicago river, as well as local drains as far north as the source of the Chicago river and south in The towns of Lake and Cicero would also come Hyde Park. within the limits of the drainage district proposed. In reversing the city sewers such fall should be given to them that they would be self-cleansing. The Fullerton avenue conduit could be used for the purpose for which it was constructed, or it could be converted into a useful adjunct of the city's water supply system. The forks and branches of the Chicago river at the south end would purify themselves, as their contents would gravitate toward the new cut in the Desplaines valley. The current in the New river would be at the rate of 2.15 miles per hour. The water in the Chicago river would be changed every twenty-four hours, and the water of the entire Chicago river would become as pure as that of the lake, and The effect upon the waters at the point of disremain so. charge would be to improve them greatly.

To carry this project into effect would require State legislation creating a drainage district and a commission to carry out the provisions of the law. The estimated cost of the New river was \$6,850,000 but it was thought the sum of \$12,000,000 would be necessary to develop the scheme in all its necessary details. Commissioners should be authorized to borrow money on the credit of the district. A loan for the purposes required, it was thought, if redeemable in thirty years, would be readily taken at 4 per cent. At a low assessed valuation of the property of the district a tax of two mills would be sufficient to pay the interest and provide a sinking

fund for the principal.

The importance of this report is found in the fact that it suggested the idea which developed into the law of 1889 creating the Sanitary District and providing for the drainage channel.

DRAINAGE AND WATER SUPPLY COMMISSION.

Prompted by the recommendations of the Chicago Citizens' Association and the urgent appeals of the press, the City Council passed a resolution on January 27th, 1886, authorizing the creation of a Drainage and Water Supply Commis-Mayor Harrison appointed Rudolph Hering as chief of the Commission. Benezette Williams and Samuel G. Artingstall were made assistants. A preliminary report was made by the Commission in January, 1887. In transmitting the report to the City Council Mayor Harrison recommended that a law be enacted to create the new metropolitan district suggested with power to issue bonds or levy assessments and to prosecute the work. The work of the Commission was not carried to a conclusion because the City Council was unwilling to appropriate the funds necessary for its expenses. The preliminary report was as follows:

CHICAGO, January, 1887.

To the Honorable Mayor and City Council of the City of Chicago:

GENTLEMEN:

On January 27, 1886, your Honorable Body passed a resolution authorizing the creation of a Drainage and Water Supply Commission. After being amended February 23, it read as follows:

"Whereas, pure water and scientific drainage are necessities of this community, and the people demand a system of water supply and drainage adequate to meet the requirements not only of the present, but of years to come, nor will any temporary expedient or makeshift

satisfy them; and

Whereas, a thorough and permanent system of supplying pure water to our citizens and caring for the drainage of the municipality cannot be paid for out of current taxation, therefore it is desired that a plan shall be devised and perfected before the next meeting of the Legislature to the end that necessary legislation may be had.

For the purpose of carrying into effect the objects sought, there is recommended the appointment by the Mayor of a commission to consist of one expert engineer, whose reputation is so high that his opinion and report will command the respect of the community, and with him one or two consulting engineers of like experience in engineering and sanitary matters. The duty of this Drainage and Water Supply Commission, made up as above set

forth should be to consider all plans relating to drainage and water supply which may brought to its attention: to make such examinations and investigations and surveys as may be deemed necessary; to collect all information bearing on this problem; to consider all recent developments in the matter of sewage disposal, and their application to our present and future needs; to consider and meet the necessity of increasing our water supply and of protecting the same from contamination; to remedy our present inadequate methods of drainage and sewage disposal; to consider the relations of any system proposed to adjacent districts, and whether there may not be a union between the city and its suburbs to solve the great problem; to determine the great question as to the interest which the State and the United States may have in the disposal of sewage by way of the Illinois river: to devise plans to meet any objections thereto, if such a system shall be thought best; and, in general, to consider and report upon any and all things which relate to the matter of water supply and drainage of the City of Chi-

The Commission should report on the whole matter committed to it in the most full and comprehensive manner, with maps, plans and diagrams complete, and accompany the report with estimates of the first cost and annual requirements for the maintenance of the system pro-

posed.

The report of the Commission should be made as early as practicable, and not later than the convening of the next session of the Illinois Legislature in January, 1887.

In consideration of the foregoing, be it

Resolved, That the Mayor be and is hereby authorized and directed to employ on behalf of the city one expert engineer of reputation and experience in engineering and sanitary matters, at a salary not to exceed \$10,000 per annum, and also to employ such consulting engineers, not exceeding two in number, as may seem necessary, and such assistant engineers as may be required, all to be paid according to services rendered, for the purpose of carrying out the objects set forth in the preamble hereto. For the fees of said assistant engineers and for all expenses connected with said work there shall be allowed not to exceed the sum of \$20,000. All fees, salaries and expenses connected with said work shall not

exceed in the aggregate the sum of \$30,000 and the same shall be paid from the water fund of the city upon vouchers audited by the Mayor and City Comptroller."

In accordance with the terms expressed herein his Honor Carter H. Harrison appointed Rudolph Hering as chief engineer, Benezette Williams and S. G. Artingstall as consulting engineers, who, together, should constitute a Commission. Mr. Hering entered upon duty March 28, Mr. Williams September

17, and Mr. Artingstall December 21, 1886.

The sewerage works of Chicago and suburbs have been planned on what is called the combined system, in which the sewers serve for the removal of both sewage and rain water. In the town of Evanston they empty into the lake. In the town of Lake View they partly discharge into the lake and partly into the North branch. From the North and West divisions and part of the South division of Chicago the drainage enters the Chicago river and its branches, and from the remaining part of the South division it flows into the lake at three outlets situated respectively at Twelfth, Twenty-second and Thirty-fifth streets. The sewers of Hyde Park discharge into the lake excepting those of Pullman, where the sewage is disposed of on land. The town of Lake, including the Stock Yards district, drains into the South fork of the Chicago river.

When the sewerage works of the city were designed, in 1856, by Mr. E. S. Chesbrough, it was apprehended that ultimately some means would have to be found to change the water in the river from time to time or to keep the sewage entirely out of it. The first step toward improving the condition of the river was taken by deepening the Illinois and Michigan canal, so as to cause a current from the lake to the Desplaines river at Lockport. The next step was the building of the Fullerton avenue conduit in order to produce a circulation in the North branch; and the last step was the erection of the canal pumping works to increase the flow in the river, which had become

greatly polluted.

The influence of these works is confined to the main river and its North and South branches. But the South fork of the latter, receiving a large amount of sewage from Chicago and the town of Lake, and charged with the waste from the Union Stock Yards and packing houses, has no artificial means for a circulation of its water, and as a consequence is in a condition of great filthiness.

The accompanying diagram has been prepared to show the present pollution of the Chicago river and its branches dur-

ing the time when all of their water is discharged into the canal by the Bridgeport pumps. On the left are shown the main river and the North branch, one above the other, their combined waters forming the South branch, and reaching Bridgeport on the right where they are lifted into the canal. At the latter point the South Fork is shown as joining it, the shaded portions indicate the amount of sewage entering and passing the respective points, and the blank portions the lake water diluting it. The degree of dilution is shown by the relative areas. It diminishes in the North branch from Fullerton avenue to the South branch, and becomes still less toward Bridgeport, and finally receives the foul waters of the

South fork.

The depth and character of sewage deposits in the river and harbor, as might be expected, vary considerably. are not great in the track of the vessels, but increase toward the docks and quieter portions of the slips, where they reach a depth of from one to four feet. While the deposits in the channel are of a heavier kind, such as cinders, those in the docks are mostly a foul mass of decomposing organic matter. No form of life is found to exist above Clark street bridge as far north as Clybourn place, and as far south as Ashland avenue. The effect of this condition of the river is to endanger the purity of the water supply whenever the river, with its accumulated deposits, flows into the lake, which occurs when the rain water that finds its way into the river exceeds the amount pumped into the canal. If this excess is great, as in the spring, and occasionally in the summer months, the contamination of the lake is considerable, and must constantly increase.

To discharge the sewage from cities into comparatively large bodies of water is not only usual, but often the best method for its disposal. Dilution and dispersion thoroughly expose it to the action of the oxygen contained in both the water and the superincumbent air, and it is thereby gradually oxidized. Where the body of water is a large river with a strong current the best conditions for such purification are found. Where it is a lake in which the circulation is slight and irregular, the efficiency of the method is less and depends for its success on the character of the currents and the rela-

tive amount of sewage to be discharged into it.

The hydrographic surveys of the lake made during the past season were therefore partly for the purpose of ascertaining, if possible, the laws governing the currents, so that we

would know their effect in dispersing the sewage discharged The trend of the shore current was actually into the lake. ascertained by daily recording the direction of spar buoys placed at the Chicago waterworks crib, at Michigan City and A large number of bottle floats were thrown at St. Joseph. into the lake at different points and different times for the same purpose. They were partly single surface floats and partly double, the lower one being at varying depths according to the depth of the water. More than half of them have been picked up and returned, with place and date noted. The currents were also observed by means of large can buoys from an anchored tugboat at different points in the lake, extending from Hyde Park to Evanston, about six miles from And two general lake trips were undertaken, one to St. Joseph and back to Grosse Point, and another one parallel with the shore around the head of the lake.

When the observations are completed and compiled in detail some valuable information will be available for the question of water supply. Light will be thrown on the movement of the water under different winds, and the sudden changes of temperature of the water at the crib and on the turbidness of

the same.

The following results have a bearing on the question of sewage disposal. Where not affected by local conditions the currents practically go with the winds in water of moderate depth and quickly respond to any change. In deep water also the surface currents run with the wind, but at the bottom and even at mid-depth the direction is usually different. The prevailing current along the shore of Cook County during the past summer has been observed to be toward the north, but it is possible that this result may be different during the winter months. In the open lake wave action seems to be effective in preventing the permanent deposits down to a depth of about sixty feet; inside of the breakwater sewage deposits are found on the bottom.

The general deduction from these results is clear that, as no constant current exists which would carry the sewage away in one direction, it should be discharged into the lake at one end of the future city, while the water supply should be obtained as far away from it as practicable toward the other end; a conclusion which is being acted upon in the other large lake cities. The proper place from which to bring the water would be opposite Grosse Point, and the sewage discharge should be east of Hyde Park. While it might be practicable to allow the sewage in its crude form to enter the lake

under such conditions for many years, the necessity would arise later for clarifying it at least partially previous to its discharge. It could not be allowed to run into the rivers as at present, but the dry weather flow and a considerable amount of storm water would have to be intercepted and carried to the outfall through many miles of special conduits. And this entire quantity would have to be raised by pumping in order to get sufficient head to empty into the lake, while the diluted sewage during storms, in excess of the capacity of the intercepting sewers, would be allowed to discharge directly into the river.

The water supply would have to be brought from Grosse Point in large conduits to the several pumping stations scattered over the city and its present suburbs. The circulation of the water in the Chicago river and branches would have to be maintained practically as it is at present, because the removal merely of the dry weather flow of sewage would not

altogether prevent its pollution. * *

Besides the economical advantages of the Desplaines scheme, its superiority is still further emphasized by advantages of another kind. The proposed canal will, from its necessary dimensions and its regular discharge, produce a magnificent waterway between Chicago and the Mississippi river, suitable for the navigation of boats having as much as 2,000 tons burden. It will establish an available water power between Lockport and Marseilles fully twice as large as that of the Mississippi river at Minneapolis, which will be of great commercial

value to the State.

The Calumet region will be much enhanced in value by having a direct navigable channel to the Desplaines river, and by a lowering of the flood heights of Calumet lake and river. Within the city the water of the Chicago river and its South branch will get a much better circulation if it flows by gravity than if it has to be pumped, the necessity for which would remain even if the sewage should be discharged through intercepting sewers either into lake or upon land. Under either of the latter conditions an occasional overflow from the sewers into the river during heavy rains would be more objectionable than a constant discharge of sewage into a more rapidly flowing stream. Flood waters entering the lake by way of the Chicago river would carry into it much filthy matter, either suspended or deposited, notwithstanding the existence of intercepting sewers; but the proposed diversions of such waters before reaching the populated districts will for all time obviate this undesirable occurrence. Lowering the level of the North branch at Bowmanville by its diversion to the lake will be equivalent to raising the low prairie extending toward Evanston and Niles, and greatly benefit parts of these towns.

In reaching the conclusion that the sewage of the city should be discharged into the Mississippi valley, the question of water supply is materially simplified, because the lake will then at all times furnish good water wherever intakes are desired for an extension of the works.

The preliminary inquiry, made with a view to ascertain the main features of an increased supply, comprised first a compilation of data concerning the existing works both in Chicago and its suburban towns, which were collected mainly through the courtesy of the respective authorities; and, secondly, a study into the most economical method of distributing the water over the metropolitan area. The following is a brief description of the existing works:

The present intake for the public water supply of Chicago is located in Lake Michigan, about two miles from the shore, and the water is conducted to the city in two circular brick tunnels 5 and 7 feet in diameter. They extend parallel to each other under the bed of the lake, and 50 feet apart, to the north pumping works, where they are connected, and where the 5-foot tunnel terminates. The 7-foot tunnel is continued under the city for a distance of 20,500 feet, to supply the west works on Ashland avenue, near Twenty-second street.

The tunnels from the source to the shore are built at a depth of 80 feet below city datum, or low water in the lake, and the 7-foot tunnel is continued on the same level for a distance of about 11,500 feet, where, to avoid rock excavation, it is inclined upward until at the west pumping station the top is but 21 feet below city datum. The economical capacity of the two tunnels is between 90,000,000 and 100,000,000 gallons per day, or less than the present average daily consumption of water. Their maximum capacity is reached when delivering about 150,000,000 gallons per day; which is now nearly equaled by the demand during the hours of greatest consumption, and, at the present rate of increase, it is estimated that during the summer of 1887 the maximum demand for water will be at the rate of 145,000,000 gallons per day; during 1888, 155,000,000 gallons per day; during 1889, 167,-000,000 gallons per day, and in 1890, 180,000,000 gallons per dav.

To provide against accident or obstruction from ice or other cause in the main tunnels, and to provide against an inadequate supply in the near future, which appeared inevitable, a

new tunnel is in process of construction. The intake is located 1,500 feet from the shore and connection is made with

the other tunnels of the north pumping works.

The distribution of the water is effected by pumping it directly into the water mains at the north and west stations. At the north works the three tunnels are so arranged and constructed that any one of them can be emptied when desired for repairs or cleaning, and both the pumping stations still be supplied with water from the other tunnels. The total pumping capacity of this station is at present 67,000,000 gallons per day, but it will be increased to 91,000,000 gallons per day as soon as the new pumps now in process of erection are in

operation.

The connections between the pumps, stand-pipes, and distribution mains at these works have become so complex by the successive additions to the plant that an unnecessary loss of head is the consequence. As this can be remedied to some extent without great expense, we recommend that it be done at the first favorable opportunity. The station being on the shore of the lake, is not centrally located with reference to any part of the city, which renders it necessary to use a greater length of main pipe, with a consequent loss of pressure to reach the consumers, than would otherwise be the case. The total pumping capacity of the West side station is 60,000,000 gallons per day, and the connections between the pumps, stand pipes and mains are simple and effective, and the loss of pressure from this cause is a minimum. The location is better adapted to secure economical and satisfactory results, than that of the north works, and with reference to additional pumping stations which will later be necessary in other parts of the city, these works are well situated.

SANITARY DISTRICT.

Two bills were before the Illinois Legislature at its session of 1886-7 providing an adequate system of drainage for the city of Chicago. One of these was known as the Winston bill, which proposed to raise the money necessary to construct an outlet through the Desplaines valley by special assessment on the property to be benefited. The other has been known as the Hurd bill. It proposed to create a metropolitan district with power to issue bonds based on taxation to construct the required works.

It is related in a brief entitled "The Lakes and Gulf Wa-

terway," published by the Chicago Citizens' Association in 1888 and written by Lyman E. Cooley, that the joint committee of the Senate and the House to whom the bills were referred, "considered the question for several months, held many public sessions and heard much testimony on all the points at issue. The river cities from Joliet to Peoria organized to guard their interests and insisted that a channel should be specified not less than 160 feet wide and not less than 22 feet deep to carry not less than 600,000 cubic feet of water per minute. The Hurd bill as amended was reported favorably. Meantime, the question developed such broad relations and presented so many points of vital interest that a general conviction prevailed that the studies should be more fully concluded before legislation was effected and the bill was not pressed to a final vote."

Subsequently, the Act of June 6, 1887, was passed. This simply authorized the city of Chicago to construct a cut-off north of the city for the diversion of the Desplaines river, or an excess above the ordinary water mark in that stream. No action has ever been taken under the authority conferred by

this Act.

The first official step toward the enactment of the present drainage law was taken in the passage of a joint resolution introduced in the House by Thomas H. Riley of Will county, on May 26, 1887. This resolution provided for the appointment of a committee of five, consisting of the Mayor of Chicago, ex officio, two members of the House to be appointed by the speaker, and two members of the Senate, to be appointed by the president of the Senate, whose duty should be to examine and report to the next session of the Legislature the subject of the drainage of Chicago and its suburbs. "If such commission shall find upon investigation," said the resolution, "that the most practicable solution of the problem is in the construction of a waterway for the sewage from Chicago to the Desplaines river at or near Joliet, the commission shall report what requirements should be made as to the construction of such waterway and the dilution of such sewage for the protection of the health and comfort of the people along the Desplaines river at and below Joliet." The commission was required to serve without pay, its expenses to be paid by the city of Chicago. The resolution passed the House at once and the Senate on May 31.

B. A. Eckhart of Chicago and Andrew J. Bell of Peoria were appointed members of the committee from the Senate

and Thomas C. MacMillan of Chicago and Thomas H. Riley of Joliet from the House. Mayor John A. Roche of Chicago was the fifth member of the committee, by virtue of his office.

The committee held many public meetings and had many conferences with the people living in the Desplaines and Illinois river valleys during the two ensuing years. As a result of this interchange of opinion, a careful study of the necessities of Chicago and the interests of the inhabitants of the valleys, and by the aid of the best legal counsel, the committee reported on Feb. 1, 1889, an Act creating the Chicago Sanitary District, "The commission," it said, "has diligently studied the subject submitted to it in all its sanitary and commercial aspects. It has visited and surveyed the territory sought to be improved. Conferences have been held with representatives from all the leading cities, towns and villages affected. An earnest spirit has been manifested to aid in the solution of this important problem. All plans proposed for meeting the demands of the river and valley communities and the pressing needs of Chicago have been carefully examined by this commission. The plan agreed upon by the commission, as set forth in detail in the bill which accompanies this report, is believed by the commission to be most feasible, practicable and satisfactory method for all the varied interests involved."

While the bill was pending in the Legislature and when before the committee of the whole, arguments for and against were heard from prominent citizens of Chicago and towns in the interior of the State. A delegation of citizens was sent from Joliet to Springfield to urge the passage of the bill, and resolutions advocating its passage were adopted by the busi-

ness men of Marseilles and forwarded to the House.

After many amendments in the nature of concessions to the valley people the bill passed the House on April 11 by a vote of 92 to 42. After further amendments it was concurred in by the Senate on May 21 by a vote of 32 to 18. The Senate amendments were adopted by the House on May 24 by a vote of 97 to 39, and the bill received the signature of the governor on May 29. It was in force on July 1, 1889.

OBGANIZATION.

Petitions were prepared soon after the passage of the Sanitary District law, addressed to Hon. Richard Prendergast, County Judge of Cook County, asking him to cause to be submitted to the legal voters of the proposed Sanitary District of Chicago the question of organization. More than the requisite five thousand signatures were readily obtained. The petition was submitted on August 15, 1889. Judge Prendergast requested Judges Richard S. Tuthill and Samuel P. McConnell of the Circuit Court to sit with him as Commissioners. The Commission met on September 18, and heard arguments for and against the proposed boundaries of the District.

The Commissioners having fixed the boundaries of the proposed Chicago Sanitary District, Judge Prendergast issued an order on October 14 requiring that the question of the establishment of the district be submitted to the people at the election to be held on November 5, 1889. The vote was as follows: For, 70,958; against, 242.

On December 12, 1889, following the general election at which the Sanitary District was established, a special election was held for the selection of trustees. The successful candidates were John J. Altpeter, Arnold P. Gilmore, Christopher Hotz, John A. King, Murray Nelson, Richard Prendergast, W. H. Russell, Frank Wenter and H. J. Willing.

The first meeting of the Trustees was held on January 18, 1890. At the third meeting, held on February 1, Trustee Nelson was elected president; Austin J. Doyle, clerk; Byron L. Smith, treasurer; L. E. Cooley, chief engineer; S. S. Gregory, attorney, and Charles Bary, secretary. The salary of the president was fixed at \$4,000 per annum, and that of each of the other trustees \$3,000. Other salaries were as follows: Clerk, \$6,000; treasurer, \$5,000; chief engineer, \$6,000; attorney, \$5,000, and secretary, \$1,500. The clerk was required to give bonds in the sum of \$200,000; the treasurer, \$500,000; chief engineer, \$100,000; attorney, \$100,000, and secretary, \$20,000.

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LETTER OF SECRETARY OF WAR TO GOVERNOR EDWARDS OF ILLINOIS.

"War Department, February 18, 1828.

Sir:

I have the honor to acknowledge the receipt of your letter of the 28 of last month, stating that as the Legislature of the State of Illinois will, at its next session make provision for commencing the canal to connect the waters of the Illinois river and Lake Michigan, you request, on behalf of the State, that a survey of a proper route for the canal may be made by some competent officer, or officers, of the Engineer Department of the U. States, and particularly setting forth the interest which the U. States have in its judicious execution in reference to the public domain.

The canal is one in which the United States are highly interested, both as it regards the increased value which it would give to the public lands, and the convenience and

facility which it will afford in a military point of view in communicating and moving the means of defense from the Lakes to the Mississippi, and from the more settled country to the Lakes. It would therefore afford the department much pleasure in complying with your request, if it shall be in its power to do so, and should Congress place the means at its disposal, an officer or other engineer will be directed in due season to fulfill the desire of the State over which you preside.

With great respect, I am, sir, your most obedient serv-

ant,

James Barbour.
To his Excellency, Ninian Edwards, Gov'r of Illinois."

EXTRACT FROM A REPORT OF J. M. BUCKLIN, JANUARY 1, 1833.

"In making a feeder of Lake Michigan, by cutting through the dividing ridge between the lake and the head waters of the Illinois river the location of the canal is the same throughout as the foregoing, it being important in both plans to choose the lowest ground for the Summit Level, the arrangement of the lower levels being governed by the same indications in each. In the survey of 1830 of the upper part of the route, assuming the bottom of the canal at the head on the Chicago river, to be four and one-half feet below the level of the lake, no rock excavation is encountered until the line strikes the river DesPlaines, where it was ascertained by the boring to average about ten feet and the earth excavation about six feet in depth throughout the remaining distance of nine miles. By the late survey, beyond the Ausoganshkee Swamp, the rock excavation was found to increase in depth for several miles, on account of the greater elevations of the rock, which I have before had occasion to advert to in describing the location of the second division. The divisions of the route upon this plan, are the same as in the former, of which first and second division, it will be observed by referring to the estimates, are liable to any increase in the cost of construction, arising from the difference of plan, yet this increase amounts to upwards of two millions and a half, a fact that may be thought sufficient of itself to put the execution of the work on this plan entirely out of the question: Still it may not be superfluous to remark that although in the

estimate of the probable cost of the work, a liberal price is allowed for the rock excavation, the most important item; besides a sum amply sufficient to cover the ordinary contingent expenses, yet it is hardly possible to anticipate the limits of the expenditure when we consider that the bulk of the rock excavation lies below the rocky bed of the river DesPlaines and the interruption that the work will consequently be liable to from the water of the river finding its way through the numerous fissures of the rock into the canal."

Extract from the Message of Governor Duncan, December 7, 1835.

"The Governor of Illinois by proclamation convened the General Assembly in special session December 7, 1835. In his Message Governor Duncan used the follow-

ing language:

There are two other subjects of deep interest, requiring your immediate action which rendered it necessary in my judgment to convene the General Assembly at this time, the first of these in importance is the canal. It will be seen by the correspondence with Governor Coles, president of the board of canal commissioners, herewith communicated, that the effort to obtain a loan under the act of the last session entirely failed. I therefore trust that this subject will receive such consideration as its great importance demands. The sale of the alternate sections by the United States in the canal reservation at Chicago in June last furnishes the clearest evidence that the land in that reservation and the town lots in Chicago owned by the State, may be safely estimated at from one to three millions of dollars, and as the work progresses their value will increase, and it is now the opinion of well informed persons, that with judicious management a sum may ultimately be realized from them, sufficient to cover the whole expense of the contemplated canal; if, however, it should be found otherwise, I feel the most perfect confidence that the general government will extend its appropriations either in granting other donations of lands or moneys to enable us to complete this great work, which combines the interests of so many States, that it is universally admitted under every aspect of the subject to be an object of the first national import-

The time has arrived when any further postponement of this subject will in my opinion amount to a violation of a sacred public trust committed to our care, and which the interest of the State and nation admonish us to preserve inviolate. I therefore earnestly hope we shall all unite in the adoption of some efficient measures for the speedy accomplishment of this object. Regarding this great work as one that affects deeply the national interest, and consequently justly entitled to that fostering care and support of the United States government, which it has hitherto, and if required, must continue to receive. I would suggest the expediency of making it the duty of those persons who may be charged with its construction. to make reports of their progress to the National as well as the State government, so that each may be informed of the expense, progress and character of the work.

As to the size and description of the proposed canal, my views were fully expressed in my message to you a year ago, those views have undergone no change, on the contrary, the importance of making this an ample channel for the passage of steamboats, has been fully developed by the fact that the commerce of the Erie Canal has quadrupled every five years since it was completed, and that that canal is found sufficient to accommodate its commerce. In consequence of which, the State of New York, is about widening its channel, which will be attended with very great expense, as all the locks will have to be rebuilt. In addition to this improvement two other channels of communication from Lake Erie to the Ocean are about to be constructed, one is the railroad from the lake to the North River, on the southern border of New York, the other is a ship channel around the falls of Niagara, which will take a portion of the trade of this country by the lower Lakes and the St. Lawrence. Should the commerce of the Lakes continue to increase, of which there can be no doubt, all must see the importance of constructing this work on the most liberal scale.

When we look abroad and see the extensive lines of internal communication penetrating almost every section of our sister states—when we see the canal boat and the locomotive bearing, with seeming triumph, the rich productions of the interior to the rivers, lakes and the ocean, almost annihilating time, burthen and space, what patriotic bosom does not beat high with a laudable am-

bition to give to Illinois her full share of those advantages, which are adorning and enriching her sister states, and which a munificient providence seems to invite by the wonderful adaptation of our whole country to such improvements.

Very respectfully,

JOSEPH DUNCAN.

December 7, 1835."

Extract from the Message of Governor Duncan, December 5, 1836.

The 10th General Assembly of Illinois began December 5, 1836. The Governor's message was voluminous and being principally devoted to the political issues of the day. He,

however, referred to the canal as follows:

"Contracts have been made for the construction of several sections of the Illinois and Michigan Canal by which it appears that the expense of completing that work is likely to exceed very far the highest estimate ever made by any of the engineers who surveyed it. The increased price of labor and supplies account in some measure for the great difference in the estimates and the contracts. The work is of the highest importance both to this State and the United States, and no ordinary difficulty or expense should for a moment, deter us from its vigorous prosecution. The means arising from the canal lands and lots will be very large, and it is hoped will be nearly sufficient to meet the whole cost of the work. Should it turn out otherwise, additional funds will doubtless be furnished by the general government, as the national character of the work is fully established and acknowledged by several acts of Congress, the conditions of the cession of the northwestern territory by Virginia, and the universal judgment of the country; and as the work has been commenced under the auspices of the general government, it will doubtless in this, as in all other cases, furnish means to carry it through."

On the 19th of December, following, the General Assembly called upon the Governor for information relating to the oper-

ations on the canal, and received the following reply:

EXTRACT FROM THE REPORT OF CANAL COMMISSIONERS, 1836.

In obedience to the act for the construction of the Illinois and Michigan canal, the Board of Commissioners respect-

fully submit their Annual Report.

The forty-second and forty-third sections of the law under which the commissioners were appointed, make it their duty to transmit, annually, to the Governor a minute and particular report, setting forth in a plain and intelligible manner all their acts and doings in relation to the canal, and the canal lands and lots; all money received and expended, the work done and the prices allowed for it, the contracts made, with whom made and the security given by contractors the number of engineers, draftsmen, clerks and agents of every description in the employment of the commissioners and the amount of compensation paid to each; the contemplated plans of the board for future operation; the probable amount of money that will be required for canal purposes the ensuing year; the amount, time and rate of any loans authorized by law; and such other matters and things as they may see fit to add.

The topics thus especially prescribed will as far as practicable, be disposed of in the order in which they are enumer-

ated.

Immediately after the appointment of the commissioners

they were legally qualified and proceeded to business.

The board was organized at Vandalia on the 15th day of January and at their first meeting appointed Mr. Joel Manning of Jackson county their secretary. At a subsequent meeting Mr. Edward Smith of Wabash county and Mr. E. B. Talcott of Chicago were appointed assistant engineers; Mr. Samuel Hackelton of Fulton, commissioner and general agent; and the acting commissioner was authorized to engage the services of William Gooding, Esq., as chief engineer, which was soon afterwards done.

At the same period of time your Excellency communicated to the board a correspondence (accompanying document A) between yourself and the President of the State Bank of Illinois, which resulted in a four month loan of ten thousand dollars, bearing an interest of six per cent. per annum. By this arrangement the commissioners were enabled to commence their preparations much earlier than they otherwise could have done; and the amount was found amply sufficient to meet all necessary expenses prior to the June sale of the

Chicago lots, when the bank was reimbursed in principal and

interest.

On the 16th day of January the board closed their session at Vandalia and on the 27th day of March they assembled at Chicago, where all the officers who had been appointed were found ready for duty. In the meantime the treasurer, under authority of the board, had made several explanations and had caused a temporary office to be erected and furnished on one of the canal lots in the town of Chicago, and the acting commissioner had procured instruments and outfits for the engineering department. The first attention of the board was directed to that section of the work next to Lake Michigan. Its difficult magnitude and greater length of time required for its construction demanded the preference. Early in the month of March an engineering party under the direction of Mr. Talcott was put in motion commencing their operations on the summit level, availing themselves of the frozen state of the country to make examinations which later in the season would have been more difficult and less satisfactory. For the details of those examinations and of all others, the commissioners refer your Excellency to the clear and satisfactory report of the chief engineer (accompanying document B). It expresses the opinion and views of the board as well as of the engineer, hence a bare reference to it will save repetition whenever additional illustration should be deemed necessary.

In the very threshold of their administration, the board were met by appalling difficulties, involving the highest official responsibility, and the most vital interest of the State. They soon became convinced that the magnitude of the undertaking had been miscomprehended both by the Legislature and the people. The largest estimate that had been previously made was about four millions of dollars, and without regarding the enlargement of the plan, or the increased value of the means of execution, it was confidently asserted by many members of the Legislature and other citizens, whose opinions were entitled to weight, that even that estimate was far

beyond the truth.

The commissioners had but just begun their inquiries when they became satisfied that the four millions would be wholly inadequate; and before they had determined on any definite location, they saw that if the spirit of the law was adhered to, double that sum would be required. The seventeenth section of the act says that "the canal shall be supplied with water from Lake Michigan, and such other sources as the commis-

sioners may think proper." In other words Lake Michigan must be a feeder; and consequently the water of the lake must be carried into the valley of the Desplaines by a through cut, chiefly in stone, of eighteen feet deep, on an average of nearly thirty miles long. It was upon this plan that Mr. Bucklin made his four million estimate; but his canal was to be forty feet wide at the surface, twenty-eight feet base, and four feet deep; while the present law requires "not less than forty-five feet water surface, thirty feet base, and a sufficient depth to insure a navigation of four feet." It is to be constructed, too, in the manner best calculated to promote the permanent interest of the country, and a discretionary reservation is authorized on each margin with a view to future enlargement.

To the difficulty which this view of the subject presented, another was added which exercised a strong influence on the movements of the board. It was at first believed by men of experience, and countenanced by the engineer, that steam power would have been freely resorted to in order to divest the Summit level works from the water which might probably flow in through the fissures of the rocks; and that the necessity of such a resort would not only increase the expense of excavations, but deter contractors from making acceptable proposals. Under the circumstances, the board came to the conclusion that if it were practicable to obtain ample feeders from other sources than the lake, they would direct their operations for the present year to some other division of the work and call the attention of the Legislature to a change of plan. The Calumet and the Desplaines having been ascertained to be insufficient, the upper region of the Fox river, as the only remaining chance, was ordered to be examined; but after a brief, yet convincing investigation, the project was abandoned; a reference to the engineer's report will afford all the particulars of the exploration.

Nothing now remained but to go through the Summit level, or suspend the whole work. To suspend the work, even for a season, and thereby create alarm, would, in the opinions of the commissioners, have been destructive of some of the brightest prospects of the State, and ruinous to the thousands of its citizens. It was resolved, therefore, to execute the plan pointed out in the law. With that view, further more accurate surveys were made, which, if they give up hope of a reduction of cost, confirmed the practicability of the flow, and lessened the apprehension of annoyance by the influx of

water.

The next question to be decided was the size of the canal. After mature deliberation, the board determined to adopt the recommendation of the chief engineer, and construct it of the following dimensions, to-wit: sixty feet wide at the top water line, thirty-six feet wide at bottom and six feet deep. The fluctuation, or irregular tides, in the lake occasioned by the action of high winds rendered the depth agreed upon indispensably necessary to insure a navigation of at least four feet, and the commissioners were decidedly and unanimously of the opinion that the adopted width was that "best calculated to promote the permanent interest of the country." There can be no manner of doubt that a canal of less capacity would have answered all the demands of commerce for a few years, but when it is considered that this is a short and important link in the greatest chain of internal navigation known to the world; that it unites the Mississippi with our inland seasthe Gulf of St. Lawrence with the Gulf of Mexico-and the Rocky Mountains with the Atlantic coast that it passes through the most fertile and rapidly growing regions in the western valley-a region abounding in grain, in mead, in mineral, in fuel and in hydraulic power; and that it is soon to be connected with extensive internal improvements penetrating every part of our rich interior; when all these things are considered and like works are appealed to, it seems to the commissioners that few can be found so skeptical as to deny that in less than twenty years the present size will be none too large if indeed it may be large enough. Let it once be conceded that in any reasonable lapse of time a forty-five foot canal would be required to be enlarged, then the experience of New York is demonstrative that it is better to begin with the greatest size that may be wanted than trust to enlargement, since the process of enlarging is tedious, expensive and far more costly than the original work. Her abler engineers and commissioners support this position. But there are other and more immediate considerations which justify the increased size and give it great importance to the State. There is no avoiding the stupendous cost through the Summit Level. Water must be drawn from Lake Michigan, and that water will be of great value, as well for the improvement of the river navigation as for hydraulic purposes. The greater size of the canal will facilitate the passage of canal boats, overcome their burden and cheapen freights. It must have, too, a beneficial effect upon the prices of lands and town lots owned by the State; such an effect, in fact, was clearly perceptible at the recent sales in Chicago, and will doubtless be felt at every other point."

EXTRACT FROM THE REPORT OF ENGINEER GOODING, 1836.

"To the Board of Commissioners of the Illinois and Michigan Canal:

Gentlemen:

In pursuance of the duties assigned me, I have the honor to submit the following:

Report.

A party was organized early in March and placed under the direction of Mr. Talcott, senior assistant engineer, to make examinations of the Summit division of the Illinois and Michigan Canal whilst the streams were yet frozen over and an opportunity presented of making those

examinations perfectly satisfactory.

Two lines of levels were run across the country lying between Chicago and the DesPlaines river, near the mouth of Portage or Mud Lake, the one commencing near the mouth of a broad slough, on the north fork of the south branch of the Chicago River, at the point where the former canal surveys were commenced, the other on the north branch of said river and half a mile above the point

or the junction of the north and south branches.

The former line or the route of the old surveys was found to be far the most favorable, the distance for which the through cut would have to be made, and the depth of cutting being much less. This line passes over ground but little elevated above the surface of Portage Lake at an ordinary stage of water, and which is mostly inundated during the floods of the DesPlaines, the waters of which, it is well known, frequently flows across this low country into the south branch of Chicago river. A particular examination was also made of Portage lake and of the DesPlaines river, with a view of occupying portions of each with the canal should the result prove favorable. But it was found that no saving could be affected by such an arrangement. Portage lake is a succession of ponds on the same level, connected with each other and with the DesPlaines river, and extending about six miles toward Chicago river, nearly in the direction of the canal line. The surface of the water at an ordinary stage is 10½ feet above Lake Michigan and the mud in the bottom is generally found 5 to 6 feet above Lake Michigan, or from 11 to 12 feet above bottom of canal. To excavate the canal to the requisite depth through these ponds and the marshes on their borders, would be attended with great difficulty and a cost far exceeding that of making the through cut along the borders of the marshes on ground more favorable."

REPORT OF COMMITTEE, 1837.

This communication and the reports of the Canal Commissioners and their engineer were referred to the Committee on canal and canal lands, who on the 15th day of February, 1837,

submitted the following report:

The Committee on canal and canal lands, to which was referred the message of the Governor transmitting the annual report of the Canal Commissioners; also a report of the Committee on roads and canals of the House of Representatives, have had the various matters submitted to them under consideration, and submit the following as the result of their deliberations.

From the examination of those documents it will be seen, that the questions presented for consideration naturally bring before the committee inquiries touching the whole course of many years' legislation upon the subject of the canal. Questions which ought long since to have been investigated and definitely settled, and which it must be presumed have been fully considered and decided upon by previous legislative bodies, are again presented with the view of an almost entire change and total reversion of all previous legislative action. The Committee have not thought proper to assume the correctness of the policy and measures heretofore adopted without investigating the facts and reasons urged in favor of the change. In proceeding to the investigation of this subject, the committee will endeavor to divest themselves of all prejudice in favor of preconceived opinions, growing out of previous action in their legislative capacity upon the same subject. It is deemed proper, however, to state, that in the opinion of the committee it is incumbent upon those urging and proposing changes of action upon a subject of such vast importance to show that such changes are practicable, and are consistent with the public faith, and the character and dignity of the State. The first change proposed by the committee of the House is upon the Summit division of the canal line,

thirty-two miles in extent.

The proposition is to adopt the high level, as run by Mr. Bucklin, ten feet above the surface of Lake Michigan using the Calamic and Desplaines rivers for feeders.

The second is to substitute the improvement of the Illinois River, from the foot of the rapids to the head of Lake Juliet,

for steam navigation by means of locks and dams.

The reasons urged by the Committee of the House in favor of the first changes proposed are: first, the large sum which the canal will cost upon the present plan; secondly, the length of time required for its completion; third, the difficulties of construction; and fourth, that a better plan can be adopted.

REPORT OF BUCKLIN AND REPLY, 1837.

"Vandalia, Feb. 8, 1837.

Mr. J. M. Bucklin.

Sir:

I am engaged as chairman of a committee of the Senate, investigating the questions which have recently arisen in regard to the change in the plans in constructing the Illinois and Michigan canal, and particularly the question in relation to the abandonment of the project of supplying the canal with water from the lake, and resorting to the Calamic. Not being an engineer, nor familiar with the calculations in relation to the quantity of water required to supply a canal of the size contemplated, I take the liberty of asking your assistance, and request the favor of you to review the calculations heretofore made by yourself and others in reference to the quantity of water in the Calamic, and to state the quantity required for the canal as at present proposed to be constructed. You will also state if there is anything peculiar in the character of the country, to justify the erecting of a canal without providing the usual quantity of water for evaporation and leakage. All the documents, except the report made by you in 1830, will be furnished if desired.

Very respectfully, your obedient servant,

WM. THOMAS,

Chairman of the Committee on Canals, Etc."
The following is Mr. Bucklin's reply:
"Sir:

It will give me great pleasure to afford you ary in-

formation that I may possess in relation to the interesting subject which you have before you. I can, however, do little more than recapitulate the information that has been

derived from various sources respecting it.

The river Des Plaines was gauged, at Laughton's ford, by Messrs. Post and Paul, in the first survey that was ever made of the route of the Illinois and Michigan canal, and the discharge found to be 72,000 cubic feet per hour. They also gauged it at the Cache Island, eighteen miles below, when they ascertained the discharge to be 117,000 cubic feet per hour. In October, 1829, it was gauged by Dr. Howard, U. S. civil engineer, who places the discharge at 96,480 cubic feet per hour. At the same place (Laughton's ford) it was again gauged by Messrs. Harrison & Guion, on the 8th of August, 1830, and found to discharge 60,000 cubic feet per hour. The Calamic river was gauged by me in the month of September, 1830, and found to discharge estimated at 320,000 cubic feet per It was also gauged by M. Guion, assistant civil engineer in the service of the United States, about the same time, and the discharge placed by him at 1,033,000 cubic feet per hour. It may be proper to remark here that the fall of 1830 was a season of extraordinary drought.

On the Erie canal in the State of New York, the supply not being very abundant in some parts of it, great care was taken to ascertain the quantity of water required to supply the evaporation and leakage in dry seasons, and it was determined by experiment that on the middle and western divisions 100 cubic feet per minute per mile was a safe estimate 'with proper care in guarding against the waste of water.' On the eastern division 125 feet was required. On the canals in the State of Ohio, 100 cubic feet per minute was adopted as the minimum; and in the State of Indiana it has since been adopted as a standard in estimating the supply required for a canal of forty feet surface and four feet depth of water, except in one instance where the canal passes through an uncommonly

wet region of country.

The allowance of 100 cubic feet per mile per minute for evaporation and filtration was assumed by me as the basis of all calculations in deliberating the minimum quantity of water to be provided for the Illinois and Michigan

canal.

The surface of the canal as at present proposed to be constructed, is sixty feet, and bears the proportion of one and one-half to one to the surface of the canal, as at first proposed. The depth of water is now six feet whereas it was formerly four feet, consequently, the pressure of water being as the squares of the heights, and the leakage nearly as the square roots of the heights, the pressure will be more than doubled, and the leakage (taking into calculation the great surface) increased in proportion to one and one-half to one. The quantity of water then that will be required to supply the evaporation and leakage in a canal of the dimensions proposed, will be 150 cubic feet per minute per mile; and with reference to the peculiar character of the country through which the canal passes. I know of nothing which would justify a departure from the established rule, in regulating the supply of water. It is true, the upper level is situated in a very wet country, but the levels below dependent upon the summit for water, are located on ground very badly calculated to retain it, and it is possible that more than the ordinary supply may be required.

If the project of supplying the canal from Lake Michigan be abandoned, and the high level resorted to, the length of canal, including feeders, to be supplied with water on the upper level is fifty-six miles, which will require 8,407 cubic feet per minute to supply the evaporation and leakage, and a further supply of 2,112 for lockage, making in all a minimum supply of 10,512 cubic

feet per minute.

Very respectfully, your obedient servant, J. M. Bucklin."

EXTRACT FROM THE REPORT OF CANAL COMMISSIONERS, 1837.

The second reason urged, viz., that the cost of the improvement will be greatly diminished will not be controverted, but of the value of that improvement compared with the value of the canal and the comparative advantages of the two descriptions of improvements, have not been discussed in the report.

It is a work national in its character, and the people of Illinois should rejoice at the opportunity offered of being instrumental in executing a work of such vast magnitude and importance. The eyes of the civilized world are resting upon us with intense interest, for our success in a work which

promises such extensive and incalculable advantages to these United States. The people of the United States are looking to the completion of this work, as forming the last link in an endless chain which shall forever hold these United States in the bonds and pledges of union, and your Committee ask in the name of the civilized world, in the name of the people of the United States, and in the name of Illinois, that no local, sectional or private interest be consulted in the decision about to be made.

The magnitude of the work, and the difficulties attending its execution have been long known and considered. The representatives of the people did not engage in the work without a due consideration of those difficulties. The interest which the nation has taken in the project is evidenced by the act of Congress changing the northern boundary line of the State by the purchase from the Indians of a strip of territory extending from the Illinois to the Lake, with an eve single to this project, by the act of Congress granting right of way to the State, and by the subsequent act granting lands of value sufficient to defray the whole cost of the work.

It has always been regarded as a national work and the nation having furnished the means for its execution, have a right to expect that the work shall be projected and executed in a manner suited to the character and views of an united and enlightened people. The fund for this purpose is admitted on all hands to be ample and no citizen of Illinois ought to be willing to see the faith of the State violated, public expectation disappointed, and the beneficence of the national government abused by authorizing any other description of work.

The question may be confidently asked-why should any one desire to disappoint the hopes and expectations of the nation in regard to the character of this work? Can it be supposed that the nation would have extended assistance by so large and extensive a grant of lands towards the execution of a project purely local, a project which at best would not accommodate the trade of Illinois alone five years hence.

To engage in such a project would be sporting with the bounty of the nation and degrading to the character of the State. Who among us would be willing to stand forth before an enlightened, liberal and magnanimous nation and proclaim the sentiment; the nation has furnished us with means to execute a great national work, and although by accepting those means, we stand pledged to use them for the purpose intended vet as a work of a totally different and greatly inferior character, can be executed for one-half the amount furnished. We will make such a work, and vest the other half of those means in bank stock or in improvements of a character purely local. If there be among us any who would be willing to assume such an attitude and in the face of the world proclaim such a sentiment, it is to be hoped, for the honor of the people and dignity of the State, none such can be found in the walls of the Legislature. Such a sentiment strikes at the very foundation of the public faith, and if acted upon would lead to a total subversion and overthrow of our free institutions. The proposition is too monstrous and involves consequences to disastrous to be entertained for a moment; and your committee will not act upon the presumption, nor indulge the idea that any citizen of Illinois will ever be found giving countenance to such a sentiment. Your committee are satisfied that the canal lands will defray all expenditures required in the construction of the canal upon the enlarged plan proposed by the canal commissioners, and they hope to see the time when its navigation will be made free to all the people of these United States.

There should be no question asked in regard to a supply of water from any other source than the lake, so long as it is known that the means furnished by the nation are amply sufficient to execute the work. In the completion of such a project, computations of time should be made with reference to the existence of the Union, and not with reference to the growth of a village. If, contrary to all calculations, eight or fifteen years shall be required for its completion, this would not justify the State or the people in a violation of their plighted faith. The time is not distant when Illinois must stand at the head and in the front of all the western states, and when that time shall arrive, nothing could be a source of greater mortification to her citizens or her sisters, than a knowledge that in her infancy, she had been guilty of a violation of pub-

lic faith.

Your committee are of the opinion that a lateral canal connecting the waters of the Illinois and Michigan canal with the waters of the Calamic is practicable, and will probably be required at some future time. Before any expenditure of money is authorized for that purpose, the consent of the State of Indiana should be obtained to the use of the water of that stream, and an agreement irrevocable, except by the consent of both states, should be entered into, fixing the terms upon which the water may be used, and the terms upon which the citizens of Illinois shall be allowed to navigate the said river.

Your committee highly approve of the decision of the commissioners fixing the size and dimensions of the canal and they cannot but remark, that nothing but the greatest industry and attention to their duties could have enabled the commissioners to have made such progress in the prosecution of the work.

It appears from the report of the commissioners that no addition will be required to the canal fund during the present year, but that provision must be made for the year 1838. For this purpose, it is proposed to sell alternate lots in the town at the termination of the canal, and other towns along the line, to the amount of one million dollars, and to authorize a further loan of five hundred thousand dollars in the event of that amount being required.

In the present state of things it is deemed bad policy to bring into market any of the canal lands. It is believed that under the provisions of an act passed during the present session, those lands can be protected against all further depredations. To carry out the views of the committee they report

a bill, and recommend its passage.

EXTRACT OF A REPORT OF JUDGE WRIGHT, 1838.

In the quarterly report of the board, transmitted to the General Assembly in July, 1837, it was stated that a correspondence had been opened with Judge Wright, an eminently "skillful engineer," with a view of the surveys and examinations required by the third section of the amendatory law passed in the previous March. In the meantime, Mr. Burnett, who is the resident engineer of the third division, was instructed to make a critical and thorough survey of the dividing ridge between the Fox and DesPlaines Rivers, and within the limits of the State. This duty he performed with great care, eliciting information from every accessible source, and indulging those persons who desired explorations of particular depressions previously supposed and asserted to be sufficiently low to afford a cheap feeder.

Judge Wright arrived at Chicago in the early part of October, and on the 20th of the same month, Mr. Burnett made a detailed report, with a topographical map and estimates of the quantities of excavation and other work necessary to effect the object on the most favorable route of the country was susceptible. At that time and through the whole summer, the DesPlaines river was generally admitted to be unusually flush

as was also the Calamic. No gauges were therefore ordered, and consequently those of the DesPlaines made by the United States engineers in 1830, and of the Calamic, by Mr. Bucklin, were adopted as the basis of the investigation. Keeping in view, however, the truth of these gauges had been strenuously controverted by the advocates of the upper level or "shallow cut" and that the capacity of the Calamic had been contended to be even superabundant, the attention of the examining engineer was particularly directed to the question, whether the Calamic could in any event be classed among waters, which the law contemplated as "Sources within the legitimate authority of the State of Illinois"; a question which his reputation for sound judgment in everything connected with the canaling, his knowledge of the requirements of Indiana, dependent on the Calamic, and his great experience in the adjustment of similar claims, pre-eminently fitted him to answer with confidence. His plain, free and very decided report, marked G, to which Mr. Burnett's is appended, will afford all the information required by the statute which enjoined the examinations. But notwithstanding the opinion of the commissioners, that the report of Judge Wright-so completely confirming their original plan-should alone determine the mode of feeding the canal, they still thought it advisable to seize the first opportunity of regauging the summit streams and examining the suitability of the country for sustaining assistant reservoirs. The past dry season rendered the measuring of the Desplaines almost unnecessary, since for nearly four months the tightest dam that could be erected would not, at the point for taking out the feeder have saved water enough to propel a single pair of ordinary millstones. Repeated gaugings from the 20th of July to the 22d of August and it was afterwards still lower, gave an average of less than the measurement of The Calamic was gauged on the 8th of August and again on the 21st of September by Mr. Talcott, the competent and indefatigable engineer of the Summit division, under the superintendence of Chief Engineer and two of the commissioners, who assisted in the operation. Every precaution was taken to render the measurements perfect, but owing to the high stage of water in the lake which flowed back upon the only point adapted to the purpose and the quantity of grass that had recently grown up in the bed of the river, it was impracticable to compute the velocity of the current from top to bottom with all the precision that was desirable. Averaging the different gauges which are believed to be over the truth, the quantity estimated was a fraction less than 7,000 cubic feet per minute, being only 1600 feet more than reported by Mr. Bucklin, but falling short 10,217 cubic feet per minute of Mr. Belin's estimate as given in the printed report. The inference is fair therefore, that Mr. Bucklin was right, and conclusive that Mr. Belin was either wrong in his calculation, or, which is more probable, that the error was typographical. It is proper to mention also that the volume of water continued to decline for some weeks after the last gauging by Mr. Gooding and Mr. Talcott, but the general sickness of the country prevented a repetition of their experiments. An attempt was made on the 8th of October, when it was found that the river had fallen two inches since the last and lowest previous gauge, but the measurement was carried no further. In regard to reservoirs, it is sufficient to say that, besides their pernicious influence upon the health of such a country, it is believed that they could have rendered but little aid in a protracted drought like the one just experienced.

In addition to the services required by law, the commissioners availed themselves of the valuable talents of Judge Wright in general consultation. He was employed to inspect the entire line, and invited to criticise freely and every part of the work in progress, as well as the plans of the chief engineer and of the board, all of which were detailed to him on the ground with great minuteness. A number of written interrogatories were likewise propounded to him, embracing every subject commented upon by the committee on Roads and Canals, in their report to the House of Representatives at the same session in which the examination was The report itself had attracted his attention before he arrived in the State. The answers to these interrogatories, and the result of the general inspection are embodied in a separate report to the board, marked H; by which it will be seen that the present plan of the canal, being the same originally adopted, has received the deliberate sanction of one of the ablest, most-experienced, and most distinguished engineers of the age. Nor was sanction given until after the most patient scrutiny, both of the plan itself, practically examined, and of all the published discussions and animadversions on the subject. Since that report was obtained the operations of another year, wide and varied in their range, develop nothing but additional confirmation. The fifteen sections, extending from Chicago river to the "Point of Oaks," eight miles, and lying through the low wet prairie periodically flooded by the DesPlaines river through Mud Lake, have been completely defended against any possible danger from surface water; and are now, by means of those defenses, accessible and tenable at any season of the year. The same plan of drainage and defense is gradually progressing from the "Point of Oaks" to the Saganaskee swamp and enough has been done to inspire the fullest confidence in the practicability and moderate cost of the work. Much less rock will be encountered than was once supposed but the earth excavation will in some few instances cost a shade more than the estimates. The quantity of water to be pumped is not greater on an average than was anticipated; although there are several sections that will require stronger machinery for that purpose than the others. The same remarks will apply to the rock cuttings between the Saganaskee swamp and Lockport, all of which have been permanently defended, and many of them so far advanced as to exhibit to the bottom every variety of material and every difficulty of excavation.

EXTRACT FROM THE REPORT OF ENGINEER GOODING AS FOUND IN THE CANAL COMMISSIONERS' REPORT FOR 1900.

The value of the water power created here and at other points upon the canal, by drawing a supply of water directly from Lake Michigan, can be fully appreciated after a season of such severe drought as the past. The DesPlaines river and many other considerable streams of the country have been nearly dried up, and probably three-fourths of the water-mills throughout a large portion of the United States have been standing still for the last three months. But had this canal been completed, there would have been during the past season an unusual supply of water, as the surface of the lake has been 9 feet 4 inches above canal bottom, or 3 feet 4 inches higher than was originally calculated upon for the supply.

EXTRACT FROM THE REPORT OF ENGINEER WRIGHT, DATED CHI-CAGO, OCT. 23, 1837.

From an examination of the various canal documents of the last session of the Legislature, it seems that the question stands as follows:

Shall the feeding water be taken from Lake Michigan by

a deep cut? or, shall the summit be raised ten feet above the lake, and fed from streams to be brought into it? It has been supposed, and no doubt correctly, that only three streams of water can be brought on the Summit level: First, the DesPlaines river; second, the Calumet river; third, the Fox river.

The DesPlaines was not in a proper situation to gauge, as there had been copious rains; I therefore take the former measurements of the United States engineers, as stated in the reports of the canal committee, at 54,800 cubic feet per

hour.

By calculation it is found that, if twelve boats pass per hour, the lockage water to lock up and down ten feet will be 475,200 feet per hour. If we then add for leakage at the locks (a small item) and for the evaporation, we ought not to say less than 500,000 cubic feet of water per hour will be required, when boats are passing as fast as they can be let through (or twelve per hour). It is true that, if boats passing each way were to meet so as to pass a boat up with the same water which passed one down, then only half the above amount of lockage water should be estimated for the twelve boats per hour, although, I believe twelve boats per hour may be passed each way, if the locks are well attended, and are in perfect order for filling and discharging the water rapidly.

These premises being admitted, we have to look for 445,200 cubic feet of water per hour more than the DesPlaines gives

us at low water.

The great objection to this immediate section of country is, that the lands do not drain freely; and for a permanent work, like the Illinois and Michigan canal, all the plans should be adopted, in reason, to make every part of the land more valuable by the drainage which the plan and the construction of the canal may give. The Illinois and Michigan canal, as now projected and under construction may truly be considered as one of the greatest and most important, in its consequences, of any work of any age or nation. In looking over this connection between the lakes and the Mississippi, it is no doubt superior in its advantages to any other which can ever be formed. It is the shortest artificial work, with the least lockage. The climate, soil, and the capability of productions of the country which will be benefited by the construction of this work, will certainly equal, if they do not

exceed, any other part of the United States; and when I view it in this light, I think it justly merits to be executed upon the best and most permanent plan, and will justify, by its revenue, any outlay which may be put upon it in reason.

Taking a view of the whole ground, and looking at the probable cost of the deep cutting, of the low level, and the length of time it will take to accomplish it, and the time the country will lose the benefit; looking, also, at the great good to the country, and the pecuniary advantage to the State and the canal, by the creation of water power at Lockport, and Juliet, I have no doubt upon my mind that the present plan of cutting down the Summit, so as to draw feeding water from Lake Michigan, ought to be continued, in preference to

any other which I can suggest.

In my remarks I have not entered into calculation to show the many expenses and losses which would result from raising the level ten feet-such as the extra lock-keeper, annual repair of locks, loss to the country and State by not having water power-the advantages of vessels of large size reaching Lockport before unlading or lading—these and many other considerations having a bearing upon this question; and I might say would admit the case to be stated by putting down the expense of the low level, and then deducting the additional value given by water power to the State property at Lockport and Juliet, and the drainage of the State land otherwise, on one side-and on the other, the cost of the high level, with two locks, the cost of the attendance (brought into capital), the cost of introducing Fox river, and other contingencies, such as damages for the injury done to lands along the DesPlaines; and I fully believe the balance would be in favor of drawing the feeder water from Lake Michigan. In these remarks and opinions, I believe I have fully complied with the act of directing the appointment. I shall, however, in another communication, comply with your wishes in regard to the details of the work, in its location, and the various points of difficulty in construction, and make full remarks upon every point.

Respectfully submitted by Your obedient servant,

Benj. Wright,

Civil Engineer.

REPORT OF ENGINEER GOODING CANAL OFFICE, LOCKPORT, DECEMBER 10, 1840.

To the Board of Commissioners of the Illinois and Michigan Canal.

GENTLEMEN:-In the regular discharge of the duties as-

signed me, I have the honor to submit the following:

In adopting the original plans for the construction of the various parts of the Illinois and Michigan Canal, I was governed by the best data that it was in my power to obtain. The oldest and most intelligent settlers in the country were applied to for information in relation to the highest and lowest water marks of the rivers, and such other facts as could in any way be useful. But the country was then very new, the oldest residents having been here but a short time, and the information received was consequently very imperfect. Hence the necessity of changing the plans in several instances as facts were obtained from actual observation. These changes, however, will in few cases increase the cost or difficulty of construction and have been made to give greater security to the canal, or confer some particular benefit upon State property.

There is probably no canal in the United States of any magnitude, and certainly none in a country so new as this, where the location has been made under greater disadvantages. It is true that three different surveys of the line had been made prior to 1836, when it was placed under my charge, but as stated in my annual report of that year, little or no advantage was derived from them, as not a single field book or note of the engineers ever came into my possession. The general facts communicated in their reports were of but little service in making our survey and location, and in adopting plans of construction. This subject is alluded to at this time, as it might otherwise be supposed that facts enough had been obtained from former examinations to secure the adoption, at once, of such plans as would require no change. Since the commencement of canal operations, critical observations have been made upon every part of the line, and though first impressions have generally been found correct, they have sometimes been corrected by a "sober second thought."

At the commencement of the canal I used every precaution in my power to submit to your board such estimates of the probable cost of it, as would not deceive the public, and these estimates were revised and corrected from time to time as portions of the work were executed, and the character of the remainder better understood.

All of which is respectfully submitted.

WM. GOODING, Chief Engineer, Illinois and Michigan Canal.

Report of the Committee on Canals and Canal Lands. Mr. Pearson, from the Committee on Canals and Canal Lands, made the following report:

Report.

The Committee to whom was referred a resolution, inquiring into the available means of the canal fund, and the ability of the State to complete that work, so successfully begun, beg leave to report:

By an act of Congress of March 30, 1822, the State was authorized to construct the canal over the public lands and ninety feet of land was given on each side of the canal to the State. The canal was to be begun in three and completed in twelve years. The act gave the State the right to use any materials upon Government Lands, necessary to complete the work. Another act was passed, March 2, 1827, which granted to the State a quantity of land, equal to one-half of five sections, on each side of the canal, and reserving each alternate section to the United States. Another act of Congress was passed March 2, 1833, granting to the State the right to construct a railroad in the place of a canal, and extending the time to complete either to five years. In consequence of this first grant, the Legislature of Illinois appointed, at the session of 1822 and '23, a Board of Canal Commissioners who made an examination and an estimate of the probable cost of the work. This estimate cost, which was only made from a surface survey, without ascertaining the amount of rock excavation, fell a little short of \$800,000. This survey cost the State over \$10,000. At the same session, a company, with a capital not exceeding one million, was chartered, to complete the canal, which was to be constructed and owned by the company for fifty years—after which the State had a right to purchase it, by paying the cost of construction and six per cent. per annum; but, in 1826, this act was repealed.

In 1829, a new board was organized, with power to make further surveys and begin the work. And by a further act, of 1831, the commissioners were authorized to lay out towns, and did proceed to lay off and sell lots in Chicago and Ottawa, and sell lands along the route. They also reported separate statements of the cost of constructing a canal and a railroad between Lake Michigan and the Illinois river. By estimates of the first work they reported its cost at \$4,043,-086.50, and that of a railroad \$1,052,488.19. At the next session, the Legislature abolished the office of canal commissioner, after these efforts had cost the State \$16,974.83. Again, at the session of 1834 and '35, Mr. Forquer, the chairman of the Committee on Internal Improvements, considering the importance of this subject (which had been referred to in the Governor's message), and with the feeling of a patriot, and the views of an enlightened statesman, again brought this question, by his report, to the consideration of the Senate, and to every citizen who felt the great importance of this enterprise to the present and future prosperity of our State.

The people of Illinois had, in this manner, and by the sale of canal lands and the beginning of the work, so far accepted the grant of the General Government, and had duly considered and determined whether they would yield this grant of land to any company, or undertake the canal on

the faith and credit of the State.

The lucid report of Mr. Forquer, of 1835, induced another enactment of the Legislature, which seemed conclusively to fix the settled policy which the State had determined to pursue, on the acceptance of this grant from the United States, and the manner in which the work was to be commenced and completed—that is, on the sole responsibility of the State. But owing to the imperfection of the act of 1835, the Governor was not enabled to borrow the money necessary to

Again in 1836, the people, impressed with the magnitude and value of this work to the growth of our infant but fast settling State, asked the Legislature to pass another law, empowering the Governor to negotiate a loan, on the sole faith of the State. This last act created another board of canal commissioners, who commenced new surveys and estimates, preparatory to renewed exertion to its completion. Contracts were let, and labor performed to the amount of \$35,744.83. In this year the commissioners laid off town lots, at Chicago, and sold them, to the amount of over \$1,000,000, with a common understanding that the canal was to be completed. The action of the Legislature thus far, and in 1836 especially, had furnished to citizens of sister states and to

foreigners, sure reasons for emigration here, and the inducing and powerful motives for the investment of their capital. They became, from that time, identified with us, and feeling a warm solicitude for the speedy success of an enterprise that was to redound to the wealth, population and

honor of their adopted State.

Such being the supposed fixed policy of the Legislature. in regard to this work, and the pervading sentiment, in and out of the State, as to the ability and determination of the people to finish it, that the population in that region and many other sections has, in consequence, increased in five years beyond any former period in our history, and beyond the most ardent anticipations of our citizens. Capital has flowed in upon us; extensive farms have been opened; mills and machinery erected on streams, in various parts of the State, likely to be advantaged by the construction of the canal; the cattle-grower on the Wabash and the more southern counties, and in the central part of our State; the grain grower of the west and southwestern part; all have participated in the expenditure of money thus far, and many emigated, with the expectation of receiving advantage by the finishing of this enterprise. Again in 1837, the Legislature, coming afresh from their constituents, after the work was begun, and impressed with its importance, passed an amendatory act of 1836, to aid in its completion. This year there was expended on the canal \$346,899.43. The commissioners also sold additional town lots and lands, to assist in paying off the canal debt. These lots and lands, also, were sold, as the others had been, with the common understanding that this enterprise was not to languish or fail, by our neglect to put in requisition the available means, so ample, and which had been looked to, ultimately, for the final completion of this work. The close relation, then, which exists between this long contemplated improvement and the lasting interests of our citizens, and so universally acknowledged and by few questioned, induces the committee, with the more confidence, to ask its final completion.

In relation to this important enterprise, the time has passed when a timid and unsettled policy will satisfy the wants and expectations of an intelligent community. In this matter, then, a steady, economical action and well directed efforts are all that the people now expect of their public agents. With nothing short of this will they be satisfied.

The committee will not dwell longer on this branch of the

subject, but will hasten to answer a question which has been recently made by some gentlemen of standing, in and out of the Legislature, "whether it would not be the part of wisdom now to abandon this canal and construct a railroad along the route?" The committee are not insensible to the benefits arising to the country from the completion of well planned railroads. But they have no difficulty in coming to a conclusion to prefer canals over railroads. We know that a few years since opinion inclined to favor railroads in preference to canals, but well may the committee remark, in the language of a clear-minded statesman, "that time and experience seem to have tested the comparative value of these two modes of facilitating the commercial intercourse of different regions, and public judgment has settled down in favor of canals in preference to railroads, whenever the country is peculiarly suited for their construction;" and there can be no doubt that nature has pointed out this, as the character of the country lying between the navigable waters of the Illinois and Lake Michigan. That railroads are better adapted to the speedy transportation of passengers than canals, seems to be admitted, and not questioned, and wherever that is the main object intended to be effected by their construction, they are doubtless entitled to a preference over canals, but such can not be the case in reference to this work. The great end to be attained in connecting these waters by an artificial communication is doubtless the promotion of the manufacturing and agricultural interests of our country, "which are already languishing for an adequate market to the consumption of the superabundant productions. These, too, are generally of a bulky character, and such, too, is the kind of many commodities out of the State, which it will be our interest to receive in exchange for our own productions. Again, the committee would urge as a preference of canals over railroads, that the former are not proposed to be used and can not well be used as monopolies which are so repugnant to the feelings of a large majority of our citizens. On a canal a trader or farmer may use his own canal boat or craft, and in this way become his own carrier and vender of his own productions, and thus save the freight and the expense of hired labor. From the nature and use of canals, they admit of competition of all kinds of business connected with them. But can the committee say the same or railroads! They are necessarily confined to a few, or the exporter has necessarily to be subject to the pleasure of a company or their supercilious agents. When constructed, a canal is steadily improved by wear and time. A railroad, on the contrary, is rapidly wearing out and needs constant repairs. This canal when completed, as the committee will shortly prove, will necessarily create an exhaustless and valuable water power at seven different points on the route. A railroad can give no such advantages. Where, too, in any country, is valuable water power more needed and will advance the interests of the people more than in Illinois?

The committee think it unnecessary further to pursue this subject, satisfied as they are, that the superiority and advantage of canals, and especially the one to connect the waters of the Illinois river with Lake Michigan, is now al-

most universally admitted.

The State having, then, in its wisdom, weighed well this enterprise, in the beginning, and entered largely on the prosecution of it, upon its present plan, and having expended towards its completion, something over four millions money, we find the question is now put by some gentlemen: "Shall this work be abandoned? or, shall it be completed?" The committee, in answering this question, which seems to them a novel and startling inquiry, after this work is thus advanced, and when nearly the whole country is vitally interested in its success, and would feel a deep mortification at its defeat, will state the facts and reasons which govern them in coming to the unchangeable conclusion that the abandonment or defeat of this enterprise would be a ruinous and suicidal policy to our State, and would the more deeply involve us in debt, if not in hopeless bankruptcy. JACOB FRY.

REPORT OF GOVERNOR FORD AS FOUND IN THE CANAL COMMIS-SIGNERS' REPORT FOR 1900.

Governor Thomas Ford in his inaugural to the Thirteenth General Assembly, delivered at Springfield, Illinois, December

8, 1842, used the following language:

"Let us offer to our creditors all that we have, at fair and reasonable prices, at least the forty-two thousand acres of land entered under the international improvement system, together with two hundred and ten thousand acres donated to the State by the general government, the railroads finished and unfinished, and all the property of the State, pertaining to the railroad system. It is believed that many of our creditors would receive this property at reasonable prices, and if so, a large amount of our debt would be immediately extinguished; if not, the lands will be continually increasing in value, and becoming more and more available as a resource in

future.

The canal lands and lots and other property belonging to it, stand upon a different footing. This property was first given to the State in trust to make the canal. It was afterwards appropriated by the General Assembly to that specific object, and solemnly pledged to creditors for the payment of money heretofore borrowed, and which money has been used in the construction of the canal so far as it has proceeded. Those creditors, therefore, have such a separate and exclusive right to its avails, as would not without their consent, justify throwing it into an aggregate fund for a general payment of debt. If they should require it, we would be bound in duty and honor to surrender it to them. It is, however, believed that no such requisition will be made. They understand their true interest too well; they know as well as ourselves, the importance and profitable character of this great work, and would prefer looking to its probable completion rather than an immediate sacrifice of the means of carrying it on, for ultimate payment. They must, and do understand that if this property should be sacrificed, the State will have no means of payment for a long time to come; whereas, if the canal progresses, to completion, the lands and lots and water power will be quadrupled in value, and the tolls alone would in a short time pay interest on all the debt contracted for its construction.

In this view of the subject, it is manifestly for the interest of the people, as well as our creditors, that the work should progress to completion, if possible before any of the canal lands or other property shall be sold, and it is equally the interest of all, that the work should not be abandoned, but prosecuted with all the energy and reasonable means in our power as one of the surest and speediest measures tending to the extinguishment of our

debt.

I therefore, respectfully recommend to the General Assembly, that the further measures to be adopted for the prosecution of the work, should be upon the plan of

a moderate sized high level canal. I am fully sensible of the great responsibility assumed by me, in making this recommendation, nothing but a full conviction of our inability to proceed with the enlarged work would justify a change of plan after it has progressed so far as it has. But, in view of our present and prospective want of credit and resources, it does seem that the enlarged work is not to be achieved by any means now in our power; and, indeed, it does seem that we are to choose between reduction and no canal of any description."

REPORT OF LEGISLATIVE COMMITTEE AS FOUND IN THE CANAL COMMISSIONERS' REPORT FOR 1900.

Report of the Committee on Canal and Canal Lands, To whom was referred that part of the ex-Governor's and Governor's message which relates to the canal.

Report.

An examination of the history and nature of this majestic work shows that it was first projected by the general government, and for more than twenty years has occupied the attention of the State of Illinois, during which time it has been the subject of repeated legislative action. From the nature of the work, its connecting with such great interests, the high source from which it emanated, and the long time its construction has been contemplated by the State, it would seem as if we might have long since expected its completion; but your committee regret to say that they find it yet remains unfinished, and it is now left for the Legislature to decide whether it shall longer continue in its present condition; whether the people shall still be deprived of its advantages, and the amount already invested in its construction, remain a total loss to the State, or whether by prompt, energetic and efficient measures they will hasten its completion and thereby secure a sure and profitable market for the abundant products of our fertile soil, relieve the pecuniary embarrassments of our industrious citizens, enhance the value of the property of the State, render available the large amount already invested, open a channel for the influx of wealth and emigration, and by the large amounts realized from the sales of canal property and the tolls from the canal, enable the State to lessen the public debt, to pay the interest upon her liabilities, redeem her plighted faith, preserve her honor and ultimately remove the burdens that are now paralyzing the energies, stifling the efforts and blighting the happiness of her citizens.

After careful investigation and close examination of the various plans and suggestions for carrying on the canal, the committee have come to the conclusion that there is but one plan which, at the present time, appears practical and worthy of consideration; they have come to this conclusion, from an examination of different letters and plans from the most distinguished citizens and capitalists in the City of New York and also from London. The views given in the letters and plans referred to are judicious, sound and practical, and if carried into effect would undoubtedly secure the completion of the canal and the ultimate payment of the whole debt of the State. There is no interest so immediately identified with that of the State as the interest of the bondholders. Whatever tends to raise the price of bonds benefits them alike with the State, and whatever plan insures the completion of the canal, confers alike benefits to the State and her creditors, for when once completed the canal not only opens new markets to the citizens of Illinois, and increased prices for her produce, but also gives greater security to the bondholders for the full payment of their interest and principal. So it will be readily seen that if a mutual arrangement, satisfactory to the State and her creditors, can be entered into to insure the speedy completion of the canal, it is the policy of both so to do. The time for theorizing upon abstract principles, for indulging in dreams of future greatness, or splendid schemes of grandeur has passed. We can no longer dwell upon what a sovereign state should be able to do, but we must complete things as they are; we must look at sober realities, and make the most judicious use of the little that remains of our imaginary wealth and apply those means yet within our power in repairing the ruined fortunes of the State. If we attempted to rear a structure of too gigantic proportions, one which fell of its own cumbrous weight, it does not become us to spend our time in vain regrets and grieve in idleness over our disappointments, but let us gather what yet remains uninjured from the ruins and erect a fabric more proportionate to our means. The proposition for carrying on the canal made by many of the creditors of the State, is as follows:

First, the State to convey all the canal lands, town lots, water power, coal beds, stone quarries, and all the canal property, together with all the tolls that may be derived from transportation upon the canal to trustees, who shall hold the

aforesaid property in trust for the canal bondholders. The aforesaid trustees to be appointed as follows: Two on the part of the creditors, and one on the part of the State. The canal bondholders are to subscribe a sum sufficient to complete the canal, to be disbursed by the trustees in the construction of the canal. The trustees to have all the powers given to the canal commissioners. After the canal shall be completed, the trustees are to proceed to sell the canal property from time to time, as the demand may require.

In recommending the adoption of the foregoing plan, your committee have only been influenced by a desire to forward the interests of the canal. In all the attention they have been able to bestow upon the subject, they have been unable to discover any other plan that would be likely to insure the speedy completion of the canal. They have not thought proper to dwell upon any of the other various plans that have been suggested or presented before them for their consideration, simply for the reason that none of them come from the parties who would be required to make the necessary advances to complete the canal. It would be a matter of doubt and uncertainty, even if any of them should be consistent with the interests of the State, whether they would be accepted by the capitalists. The propositions upon which the foregoing plan is based, come from a source entitled to the highest credit, and propose all that the State can reasonably desire, and have, therefore, been more attentively considered by your committee.

We believe there are many causes that will tend to render the communication by the canal and lakes annually more favorable to our citizens.

In conclusion, the committee will say that they have no doubt but that it is within the power of the State to secure the speedy completion of the canal. And the committee also believe that when completed, it will enable the State to extricate herself from her present pecuniary embarrassments. Let Illinois be true to herself, carefully guard her honor, be prudent and economical, show a rigid adherence to principles of justice, and prove to the world by all her acts that though poor, yet she is honest, and she will soon rise above her present difficulties, and ere long will hold that proud position in the Union which she is destined to occupy.

The completion of the canal will secure to our farmers a rich reward for their honest labors, good prices and a ready sale for their produce, revive business, restore prosperity, and give a new impulse to trade and commerce. Emigration will pour into the State, our vacant lands will be sought after, our wild prairies will be transformed into rich and beautiful farms. Capital will flow into the country, industry will be encouraged, enterprise will be stimulated, and the citizens of Illinois will soon become prosperous and happy.

REPORT OF ENGINEER GOODING, DATED LOCKPORT, DEC. 1, 1842.

From the foregoing extracts it is plain that no difficulty was anticipated in relation to a cheap supply of water for the canal. If the streams on the route would not afford sufficient water, it would cost no more to procure a never-failing sup-

ply from Lake Michigan than from these sources.

The surveys of the canal route by the United States engineers in 1830 and 1831, seem to have been made more to ascertain the practicability of the work and the general character of the route, than with a view to obtain data for a particular estimate of cost. In fact, I believe, that no estimate of the cost of the work was submitted until the summer of 1834, at least I have never seen one of an earlier date. Gen. Gratiot submitted his estimate in June, 1834, of the cost of constructing a steamboat canal from Chicago to the mouth of the Little Vermilion river. The dimensions were as follows, to wit:

For the first twenty-seven miles from the lake, or to the running out of the lake level, the canal, except two miles, is one hundred feet wide and ten feet deep. The remaining two miles to be distributed in short sections, at convenient distances, "to be two hundred feet wide, to accommodate boats while detained in changing cargoes without interruption to the navigation." The remaining distance of sixty-five miles "to be not less than one hundred feet at the surface and six feet deep." The total cost of this canal was estimated at

\$4,299,439.81.

The contest in the winter of 1836-7 closed by the passage of a law authorizing the canal commissioners to prosecute the work upon the present plan, but requiring them to procure a skillful engineer from abroad to examine and report whether "a supply of water from sources within the legitimate authority of the State of Illinois," could be procured without resorting to the lake, or, in other words, whether a shallow cut, or high level canal could be supplied with water, and if

so, whether enough could be gained to make it for the interest of the State to change the plan which had already been adopted by law, after a considerable portion of work had been

placed under contract.

Judge Wright was the eminent engineer whose services were secured by the commissioners, and the substance of his report upon this subject is well known to the public. From the time his report was published until the work was nearly suspended on account of the financial embarrassments of the State, little was said about a change of plan. It was supposed that there was nearly or quite canal property enough to complete it upon the deep cut plan, and so long as the State could procure money to carry on the work, little solicitude was felt as to the plan, though it was still believed by many that it should have been changed, or that the high level should have been adopted at the outset.

It never having been made a part of my duty to investigate this subject, I have hitherto deemed it improper to allude to it in my reports, but at this important crisis in the affairs of the canal, when the work is nearly suspended, the State credit gone, our citizens discouraged, and no hopes entertained of brighter prospects until the completion of this important improvement is rendered certain, I shall present a few facts and conclusions which I believe, may be of some public utility, and which certainly can do no injury to the

best interests of the canal. " "

Were the deep cut plan to be carried out at an average stage of Lake Michigan there would be an abundant supply of water drawn from the lake, not only for navigation, but for waterpower. There would be no locks to obstruct the passage of boats or lake vessels of good size between Chicago and Lockport. The water power at Lockport and Juliet would be greater and more permanent (at the usual stage of the lake) than it would be upon the shallow cut plan. The navigation of the canal would not be liable to interrupt from breaches in dams or embankments, and the plan is much more magnificent. Besides, if the waters of Lake Michigan do not get through this channel to the Mississippi, there is no other through which they can be conducted, and a great deal will have been said for nothing about mingling the waters of the lakes and with those of the Gulf of Mexico.

In constructing the Illinois and Michigan canal of the dimensions now adopted, reference has generally been had to a future enlargement. Through all the towns and proposed town sites, as Lockport, Juliet, DuPage, Ottawa, etc., the canal is nearly double, and in some instances more than double, the ordinary width. In the deep cutting, the spoil-banks were removed a sufficient distance to leave room for the widening of the canal, and in few instances, if any, would there be any additional damages to be paid for property. However remote the period may be when an enlargement of this work will take place, it is certainly the part of wisdom to provide for it now. That it will be enlarged, sooner or later, there can be no doubt, and also that the Illinois river will be so improved (an indispensable improvement) as to meet the enlarged capacity of the canal.

Disheartened as our citizens now are, and prostrate as the credit of the State at this time is, my views upon this subject may be considered the wild speculations of an enthusiast. But such are the natural resources of the country, that with prudent legislation on the part of our legislators, and industry and frugality on the part of our citizens, this state of things cannot long continue. This great national thoroughfare once completed, and new life will be given to the whole country, and the prosperity of the State secured

for all time to come.

All of which is respectfully submitted,

WILLIAM GOODING, Chief Engineer.

Canal Office, Lockport, Dec. 1, 1842.

REPORT OF OPENING OF CANAL, 1848, AS FOUND IN THE CANAL COMMISSIONERS' REPORT FOR 1900.

The following excerpts from the report of the board of trustees for the year ending November 30, 1848, completes this report so far as it relates to the inception, construction, and

completion of the Illinois and Michigan canal.

On the 24th of April, the board while in session at Chicago, received a report from the chief engineer, stating that the canal was so far completed as to be in navigable order, that the first boat (the General Fry) had passed over the Summit level from Lockport to Chicago on the 10th of April, and that the first boat which had passed through the entire length of the canal from LaSalle to Chicago (the General Thornton owned by Mr. Isaac Hardy) had arrived at Chicago on the 23d of April.

As a matter of some interest connected with the arrival

of this boat, it may be stated that sugar, etc., from New Orleans, brought by the General Thornton to Chicago was received at Buffalo (via Mackinaw), on the 30th April, some two weeks before the first boat had reached Buffalo by the Erie canal.

REPORT OF THE CALUMET DAM, 1856, AS FOUND IN THE CANAL COMMISSIONERS' REPORT FOR 1900.

Chicago, April 10, 1856.

Capt. William H. Swift, Western Railroad Office, Boston, Mass.

Dear Sir:—I returned from Indianapolis yesterday. I had an interview with Gov. Wright and the officers of the State of Indiana, and laid before them my views in regard to the Calumet ditch; and the result was, the Governor will suspend all action in regard to the matter, until after next meeting of Legislature.

He will call their attention to it in his message, and unless instructed so to do by the Legislature nothing farther will

be done.

He will see that the canal trustees are notified, with a view of their being heard before the Legislature. The Governor and state officers treated the matter with great courtesy, and manifested liberal views; and unless the speculators in swamp lands raise a great clamor and influence the members of the Legislature, I think we can induce them to let the matter rest.

I will state very briefly the grounds on which I asked them

to desist.

1. The Illinois and Michigan canal trustees are riparian owners of both banks of Calumet, continuously in the State of Illinois, and to some extent (by paying damages) in Indiana.

2. They as such have a clear legal right to have the stream continue to flow in its original channel, and Indiana cannot legally divest it or any part of it. If she attempts to do so,

the court will enjoin her.

3. Indiana knew by her engineers, etc., that the canal trustees of Illinois proposed to make this dam as early as 1836. She contemplated connecting the Wabash and Michigan canal and to use Calumet and our Calumet feeder for that purpose. A meeting of engineers of both states was had and plan discussed and perhaps by mutual consent adopted.

At all events Indiana knew what we were doing—stood by and saw without objection. Illinois expended seven or eight millions on this plan. She is now stopped from raising the objection. She ought to have objected, if at all, before Illinois expended her money.

This acquiescence amounts to a license by Indiana, and a court of equity would enjoin her from interfering now, etc.

I will reserve details until I see you; I employed the State librarian to look up and prepare and send me all the legislative reports of commissioners, engineers, etc., to be found

in Indianapolis on these subjects.

The difficulty in the case is, our dam throws back-water into Indiana, and is clearly illegal, except for the acquiescence of that State. I will reserve full details until we meet, as I can explain matters much more satisfactory then, than by writing. Meanwhile, we will have until next winter to examine our position.

Very truly yours, I. N. Arnold.

REPORT OF THE COMPILER OF RECORDS AS FOUND IN THE CANAL COMMISSIONERS' REPORT FOR 1900, PAGE 269.

In the various histories of Illinois there has been little said of the Illinois and Michigan Canal. The work was national in its character and its progress was observed with intense interest throughout all the states. The interest which the general government had taken in the project is evidenced by the act of Congress changing the northern boundary lines of the State, by purchasing from the Indians a strip of territory extending from the Illinois river to Lake Michigan—by the act of Congress of 1822 granting the right-of-way to the State and the act of 1827 granting land to defray the cost of construction.

The history of the canal is so interwoven with the early history of the State that in leaving it out of consideration, the historians were leaving out much that is now of interest. The teachers in the public schools of Chicago and Joliet are interesting themselves in its early history for educational pur-

poses.

Prior to 1836, the magnitude of the undertaking was little understood by the majority of our State Legislatures and our people generally. The agitation of a deep waterway to connect the Great Lakes with the Mississippi was begun in 1812 during the war with Great Britain, and was vigorously

commented upon by the "Niles Register" of that period. That such a waterway would ultimately be accomplished, was the opinion of the men engaged in the construction of the canal. In 1842, William Gooding, an accomplished engineer, employed from 1836 to 1871 in the work of construction, etc., wrote as follows:

"In constructing the Illinois and Michigan Canal of the dimensions now adopted, reference has generally been had to a future enlargement. Through all the canal towns the canal is nearly double and in some instances more than double the ordinary width. In deep cutting, the spoil banks were removed a sufficient distance to leave room for widening and deepening. In few instances, if any, would there be any additional damage to be paid for property. However remote the period may be, that it will be enlarged sooner or later, there can be no doubt. And also that the Illinois river will be so improved as to meet the enlarged capacity of the canal."

All the documentary evidence that can be found at the State capitol at Springfield or among the canal records, has been reproduced, consisting of the reports of the early commissioners and engineers (many of them never before published), extracts from messages of the Governors, from Session Reports, and Reports of Committees of the House and

Senate, on canal and canal land.

Respectfully submitted, E. W. WILLARD, Land Agent.

EXTRACTS FROM ANDREAS HISTORY OF CHICAGO.

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EXTRACTS RELATING TO THE EARLY HISTORY OF CHICAGO FROM ANDREAS HISTORY OF CHICAGO—VOLUMES ONE, TWO AND THREE.

Water Works. The first public effort made by Chicago to assist her inhabitants to a supply of fresh water, dates from November 10, 1834, when the Board of Trustees paid \$95.50 for the digging of a well in Kinzie's addition. But the settlers early cast longing eyes towards the lake, realizing that that source of water supply was the true one and not to be compared to the sluggish and unprepossessing river. some years private enterprise reaped a comfortable little financial harvest in the operation of water carts, which ran to and from the lake. These carts were two wheeled vehicles. upon which hogsheads were mounted. Having driven into the lake, generally at the foot of Randolph Street, the watermen loaded up their reservoirs by means of pails, and then commenced their journeys "around town." Backing their carts up to the doors of their customers' houses with a short leathern hose they filled the barrels or other receptacles placed there for the purpose. The price per barrel varied, according to competition, from five to ten cents. But there came a time when water-carts, tin cans, wooden pails and barrels were deemed too crude as "water works," and when even such persuasive and enterprising carriers as Peter Wolfe were thought to be behind the times. January 18, 1836, the State Legislature passed a law incorporating the Chicago Hydraulic Company. On March 19, an organization was effected as follows: George W. Dole, President; Gurdon S. Hubbard, David Hunter, Gholson Kercheval, William Forsythe, directors; and Edward W. Casey, secretary. The other incorporators were James H. Campbell, R. A. Kinzie and Solomon Wells. The capital stock was limited to \$250,000. The charter was to continue in force seventy years. company was allowed four years from the passage of the act in which to commence the construction of the necessary works. Although incorporated, the panic of 1837 so disarranged the affairs of the new company that it did not get fairly to work until 1840, when the four years had nearly expired. Ira Miltimore was then appointed machinist and superintendent of the works, and commenced at once to build a reservoir at the corner of Lake street and Michigan avenue, on the ground afterward occupied by the Adams House. Not until the spring of 1842 was this first water works system completed. The American of May 24 speaks in flowing terms of the purity of the supply. The same paper of June 10 gives the following interesting facts in regard to the completion of the great

undertaking:

"The whole outlay of the company has been about \$24,-A large two-story brick building has been erected with a pier running into the lake. The steam engine is of 25-horse power. The working-barrel of the pump is fourteen inches in diameter and forty-four inches strokedouble action. The suction pipe by which the water is drawn from the lake, is also fourteen inches in diameter, and three hundred and twenty feet in length. The pump raises upward of twenty-five barrels of water per minute, thirty-five feet above the level of the lake. are two reservoirs, each of the capacity of one thousand two hundred and fifty barrels, one only of which is complete. A space of about fifty minutes is required to fill each of the reservoirs, equivalent, of course, to raising one thousand two hundred and fifty barrels in fifty minutes. The reservoir is of sufficient elevation to throw the water into the second story of any building in the About two miles in length of pipe are now laid down. The machinist under whose direction these works have been put into such complete and successful operation is Mr. Ira Miltimore. We allude to this gentleman with the more pleasure that it was for a long time confidently predicted that his undertaking would prove an entire failure. We know that though he had perfect confidence in his ability to accomplish his task, these predictions were to him a source of constant and harassing anxiety. It can scarcely be imagined how keenly intent were his feelings when the works were upon the point of being put into operation. The triumph, or it might be the disgrace, of the machinist was at hand. His feelings at that moment were assuredly not to be envied. were to be envied when the regular evolution, the easy play, the harmonious action of every part of the machinery, announced the complete triumph of skill."

Elsewhere, and officially, the old hydraulic works have been described as consisting of an 18-inch inlet nearly seven hundred feet long, extending from a crib in the lake to a well fifteen feet deep, the inlet bending down nearly to the bottom; of pumping works on the lake shore at the foot of Lake street; and of wooden supply pipes, of which latter, before the abandonment of the works, there were several miles, none of which exceeded six inches in diameter. The wooden pipes

were frequently dug up, in excavating for the laying of sewers and iron water pipes, and appeared to be perfectly sound,

twenty-five years after they were laid.

The Common Council in December, 1841, contracted with the Hydraulic Company to supply the city with water for the extinguishment of fires. The schedule of rates for domestic and manufacturing supply was published in April, 1842, and ranged from \$10 per annum for a family of five persons, to \$500 for large services in manufactories. The pipes from the mains to buildings were furnished at private expense.

In 1842 James Long entered into arrangements with the Hydraulic Company to do their pumping for supplying the city with water for ten years, without cost to the company, in return for the free use of the surplus power of their engine. Subsequently Mr. Long referred in the difficulties of

his post in the following words:

"In winter the pipes would be disarranged by the heaving of the frost, and I had frequently to spend hours at a time to caulk up the joints by throwing on water and thus freezing up the cracks before we could make the pumps available. When the end of this pipe from the pier was first put down it was three or four feet below the surface of the lake, but in 1842-43 the lake had receded so far as frequently to leave the end out of water, particularly when the wind blew from the south."

In addition to the work which he accomplished for the city, Mr. Long erected the "Hydraulic Mills," corner of Lake street and Michigan avenue, which he operated with the "surplus power of the twenty-five horse engine." The building cost about \$12,000, was of three run of stone, and the mill did good business until the second water works were constructed,

in 1853, when the enterprise was abandoned.

The great expectations entertained regarding the blessing which was to be brought to the homes of the people of Chicago were not realized, even within the next decade. During the fall of 1847, especially, the water supply was of a quality which called for purification. In August, ex-Street Commissioner Phillip Dean cleaned the works and repaired them. He was then acting as agent. But citizens were already putting the pertinent inquiry, "What good can Mr. Dean do, unless the pipe is extended out into pure water!"

The matter was so serious that everyone took part in the discussion. In the spring of 1848, at the season when little fishes were generally pumped into the reservoirs and thus distributed over the city, to the horror of the clean and fas-

tidious housewife, the public prints were full of "water works," and many shafts of ridicule were leveled against the primitive system of supply under which the city was suffering. A committee was appointed by the Chicago Mechanics' Institute, consisting of S. D. Childs, A. F. Bradley and W. H. Kennicott, to suggest a plan for getting water from the lake. They reported in May with a diagram, and proposed to lay down a pipe three feet below low-water mark; to extend it out into the lake at a point opposite First street to a sufficient distance to pass the muddy water, and then to continue the pipe down the center of said street, crossing the Chicago River near Mr. Gage's steam mill, and continuing it to the western boundary of the city. At the crossing of each alternate street lateral branches might be taken; the pipes to be of wood and to cost about \$2,000 per mile. By carrying the pipes into twenty feet of water and attaching an elbow to that end, at least ten feet from the bottom, the water so drawn would be equally free from the floating impurities and the disturbances of the bottom; the water thus drawn to be introduced into two reservoirs, to be erected at the margin of the lake, each capable of holding twenty thousand cubic feet of water. Into the one nearest the lake the water should be first introduced, drawn off from the top and carried by an elbow to the bottom of the second reservoir, from which it should be drawn off again near the top, to be carried through the city by wooden pipes running down First street. The works then in operation (so it was computed) were throwing into the reservoirs a column of water equal to twenty-eight thousand cubic feet every twelve hours. This was drawn from the bottom of the lake, poured into the top of the reservoir and taken out at the bottom where the sediment must, of necessity, have been thrown.

Another influence, besides the quality of the water-supply, was at work to bring the life of the old Hydraulic Company to an end. A portion of the South Side, and a very small part of the West Side, were well supplied with water, while the whole of the North Side, and large districts of the other territory, were obliged to depend upon wells and the watermen, a number of whom were still kept busy bringing water from the lake. Many poor people, who were not able to take advantage even of these necessities to health, drew their supply from the filthy river. During 1850 the company laid one mile of pipe, making in all nine and a quarter miles in use. Of one thousand hydrants, eight hundred were used by families, the remainder by stores, public houses, livery stables, etc. It

was estimated that not over one-fifth of the city was being supplied by the company. For a large and rapidly growing city this state of affairs was alarming, especially as the general health was perceptibly suffering. In April, 1850, a meeting of citizens was held at the city hall for the purpose of devising means of supplying the city with pure and wholesome water. The following gentlemen, with the chairman of the meeting, Peter Page, were appointed to obtain facts and suggest remedies: South Division, R. H. Foss and T. M. Moody; West Division, A. S. Sherman and Luther Marsh; North Division, R. J. Hamilton and William E. Jones. It was through the efforts of these gentlemen, sustained by the general public sentiment, that a company was incorporated by the city during the succeeding session of the Legislature. The act approved February 15, 1851, to incorporate the City Hydraulic Company, provided for the organization of a board of water commissioners, composing John B. Turner, Horatio G. Loomis and Alson S. Sherman. This board entered on their duties of office June 18, 1851, and ten days later William McAlpine was appointed Chief Engineer. Under his directions the second water-works of Chicago were constructed. To point out distinctly the reason which the city assigned for the construction of such expensive works, an enumeration of buildings, etc., in which water-pipe were proposed to be first laid, was made in July, 1851. The total amount estimated to accrue from water-rates for the year succeeding the completion of the water-works was \$37,366.

"The commissioners stated that the water will be taken from the lake north of the pier, at or near the termination of Chicago Avenue. There will ultimately be required in the carrying out of this plan three reservoirs, one of which will be located in each division of the city. The water will be taken from the lake at a distance of about six hundred feet from the shore, and conducted by an inlet pipe to a well, which will be within the engine-house, on or near the beach. From this well the water will be forced into the reservoirs, to a height of eighty-five feet above the surface of the lake and about seventy-five feet above the surface of the general level of the city, by a non-condensing engine of about 170-horse power. The pipes used will be of iron. Iron tanks will be used for the reservoirs. The estimated cost of constructing the work upon this plan, including the cost of about forty-eight lineal miles of distribution pipe, which it is supposed will be adequate to supply the inhabitants of the city, when its population will be one

hundred thousand souls, is \$570,000.

Engineer McAlpine made his report September 26, 1851. His assistant, E. W. Smith, had remained in Chicago for over a month, to take soundings in the lake at the several places suggested by the board of commissioners, and also to examine the branches of the river where the water pipes were proposed to be carried. Mr. McAlpine submitted four plans, with estimates for the cost of carrying them out. The plan substantially adopted was the fourth. An estimate was made that the total cost of constructing the works would be \$335,439.59 and that the annual expenses would amount to \$18,000. The whole plan was submitted, as applying to a city which would number one hundred and sixty-two thousand souls in 1875. The system was considered as amply sufficient to cover any possible growth of the future, and the estimate was considered as a submitted was considered was considered as a submitted was considered was considered

sidered by many to be quite extravagant.

It would not be in human nature for the old Hydraulic Company to allow the new corporation to prosecute their enterprise without bitterly opposing it. The former claimed exclusive rights, and held that before the commissioners could proceed a step they must first purchase the old company's property and franchise, or its franchise alone. The Hydraulic Company claimed, without the income which was then being derived from water rents, that the tables of the new commissioners would be \$15,000 less yearly than they calculated. As to the paucity of the water supply they stated, "that a "charter was obtained for supplying the North Division of the city with water, but excepting such preliminary steps as were thought necessary to secure their charter, we believe they have advanced no farther. In 1850-51, the charter was extended, and calculating to supply the whole city, the company finding the limit of \$250,000 in their charter too small, they are seeking power to borrow at once \$350,000." After showing the advantages which the city would gain by purchasing their works, and that it was impossible for them to levy taxes upon the territory now occupied by them, the directors of the company intimated that unless the matters were settled, an injunction would be brought to prevent the building of the new works. The directors of the old Hydraulic Company, at this time were B. S. Morris, William Wheeler, B. W. Raymond, J. H. Foster and M. Laffin.

On March 2, at the regular municipal election, only five hundred and thirteen votes were cast against the adoption of the system proposed by the Chicago City Hydraulic Company.

Of the four thousand four hundred and forty-five persons voting at that time, one thousand two hundred and forty-four did not signify whether they cared for the works or not.

In compliance with a request from the old Hydraulic Company a special committee of the Common Council suggested that the water commissioners purchase their entire interests for \$30,000, or their franchises for \$15,000, the Hydraulic Company to retain their property and income of works until July 4, 1853. The paper, however, was laid on the table and could not therefore be considered as having received a municipal indorsement. The water commissioners then went on to negotiate their \$400,000 bonds with Duncan, Sherman & Co., of New York City. The first loan was made in April-\$250,000, payable in twenty years. In June the New York Tribune reports: "Under the active demands for the Chicago City Six's, which was fast exhausting the supply, Messrs. Duncan, Sherman & Co. have advanced the rate to ninetyseven and one-half and accrued interest. They are selling faster than the city officers execute and forward them."

The Hydraulic Company got out an injunction, but the two rivals compromised their difficulties under the 19th section of the act of incorporation of the new water company, which

reads as follows:

"Said commissioners may purchase the corporate rights and real and personal property, fixtures and stock of every name and description of the Chicago Hydraulic Company and when such purchase shall be made, the said commissioners shall succeed to and become invested with all the powers, rights, privileges and immunties exercised and enjoyed by the Chicago Hydraulic Company under their charter, and shall continue to supply water to the citizens of Chicago, under the same, and collect the money and rents therefor, in all respects as fully and effectually as the Chicago Hydraulic Company can or may do, until the said commissioners, acting under the provisions of this act, shall have completed their arrangements, machinery, engines, pipes, buildings and other things provided for in this act for the purpose of providing the said city with pure and wholesome water; after which time the said Chicago Hydraulic Company, and their said charter, shall become extinct and null: Provided, always, that if the said commissioners cannot agree with the said Chicago Hydraulic Company as to what sum shall be paid the said Chicago Hydraulic Company for their property, rights and privileges, then the said company shall have the right to establish, by satisfactory proof, the actual cost of their said property, before the Judge of the Circuit Court of Cook County, upon petition to him in term time or vacation, and no greater sum shall be paid for the same than the Judge shall decide the actual cost to have been."

In April and August two loans were effected with the above named banking-house. The net amount realized from the sale of the \$400,000 bonds—six per cent., twenty-five years—was \$361,280. The difficulties between the two companies having been amicably adjusted, the water commissioners pushed their

work along with commendable energy.*

The works were commenced in the summer of 1852, and were situated near the lake, at the foot of Chicago avenue. The pump-well was built, and a portion of the thirty-inch inlet pipe was laid towards the lake, and the foundations of the building and tower were put in, which closed the work for the season. During the spring and summer of 1853 the buildings and tower were finished and several attempts made to put in place the thirty-inch wooden inlet pipe, which was designed to extend six hundred feet into the lake, and terminate in a crib of timber. The efforts to complete this were unsuccessful. The boisterous condition of the lake rendered it difficult to secure the crib in place, so the work was abandoned and the water received in a pipe, close to the shore. During the fall of 1853, the stand-pipe was put up, and the condensing and non-condensing engines were erected. The former was started December 16, 1853, and the supply of water for the city commenced in February, 1854. The original pump-well was rectangular, twenty by thirty feet, and twenty-five feet deep from floor of engine-house to bottom. The walls were of stone, six to seven feet thick. Upon those walls the engines were located; the buildings were of brick, forty by fifty feet in the clear, and two wings for boiler-rooms, each thirty and one-half by forty and one-half feet in the clear. The water tower was square, composed of brick fourteen feet at the base, eleven feet at the top and one hundred and thirtysix feet high. The interior was divided by a wall, one part designed for a smoke chimney, the other for the iron standpipe. The foundation rested upon a bed of sand, some six feet below the surface, and at one time the tower leaned fourteen inches from a vertical line. It was, however, by an ingenious method made plumb, and remained so until its demolition. The original pumping-machine consisted of a vertical beam engine, located on the north side of the building, having a steam cylinder of forty-four inches diameter and a stroke of nine feet, with two single-action pumps of thirty-four inches in diameter and five and one-half feet stroke. This engine was in use sixteen years, and continued through 1869. It was built at the Morgan Iron Works, New York, as were also the engines erected in 1857 and 1867. The non-condensing engine, erected in 1853, was horizontal. It was located on the south side of the main building, having a steam cylinder of eighteen inches, and six feet stroke, with one double-acting pump of the same dimensions. This engine was built by H. Moses, of Chicago. It was removed in the latter

part of 1856 and a larger one substituted.

During the first four months water was supplied but nine hours per day, and none on Sunday except in case of fire; after that the supply was continued regularly throughout the twenty-four hours. At this time there were but few watertakers, and having no reservoir, the water was allowed to run to waste through the fire-hydrants, in order to keep the small engine running. In the early part of 1854 the twelveinch river pipe at State street was broken by an anchor dragging from a vessel. This accident required the supply for the West Division to be forced through an eight-inch pipe across the river at Kinzie; and thence by a twelve-inch pipe across the river at Adams street for the South Division. As a temporary resort a large rubber pipe, manufactured at Boston, was procured. On its arrival its strength was found inadequate to the pressure. A new wrought iron pipe, thirty inches in diameter was subsequently put down at State street and was in use in 1869. This new main was manufactured by Charles Ressig, of Chicago, at a cost of \$3,561, and was laid by S. S. Durfee, at an additional cost of \$2,000. The connecting main was completed October 1, 1854. Thirty and one-half miles of pipe were laid up to December 31, 1854. The total cost of the works at that date was \$393,045.32. During the first year much trouble was experienced from sand being driven from the inlet pipe into the pump-well. The mouth of the pipe being only a few inches under water, near the shore, was exposed to the heavy waves of the lake. On one occasion the water was entirely stopped by a vast number of insects accumulating on the strainer. To protect the inletpipe from those obstacles, a breakwater or basin was constructed in 1855. This being dredged to a considerable depth fully answered its purpose, and was in use until the completion of the first lake tunnel. In June, 1852, the water commissioners purchased from P. F. W. Peck a piece of land

upon which to erect the South Side reservoir. The lots had a frontage of 2171 feet upon Adams street, and cost the city \$8,750. The reservoir was completed in November, 1854. was filled within ten feet of the top, or twenty-eight feet deep, on November 22, and the next morning it was found that the immense weight of water had caused the masonry to settle so that fissures were discernible on every side of the building. The water was immediately drawn off, and the various methods of patching up the job, which had already cost \$60,000, were canvassed. Various plans were laid before the Council and a committee was appointed to examine them. This committee could not agree upon one thing, viz: and it was necessary to construct substantially a new building. The water commissioners, therefore, strengthened the cracked walls as best they could with rods and braces, so that the tank could be partially filled with water and thus do some service during the winter. Pending the repairs of this reservoir the engines were run day and night. A portion of the thirty-inch inletpipe from the lake to the well was found to be defective, and a new one, three by four feet square made of oak plank, was put in at a greater depth. Considerable difficulty was experienced in laying this pipe, involving the removal of the cast wall of the engine house. Upon completion of the lake tunnel this arrangement was also abandoned and served subsequently as a waste-pipe for the water from the air pumps of the several engines.

In June, 1855, the reservoir was strengthened after the accident of the preceding fall, until it would hold eighteen feet of water, which with other charges for repairs and general expenses, brought up the construction account to \$380,070.73. A large fracture was found in the main pipe near the standing column of the works, on December 22, 1855. Notice was immediately given that the water would be cut off at Monday noon. Care was taken to have the reservoir full, and a man was kept stationed there with orders to turn on the water instantly in case of fire. The pipe was repaired within a few days, and but little inconvenience was felt by the people.

Up to December 31, 1855, there had been expended upon the construction and extension of the water-works system \$496,849.64. The whole amount of bonds issued by the water commissioners had been \$650,000. Over forty-one miles of pipe had been laid, and 4,251 buildings were supplied with water.

During the early part of 1856 the quantity of water used was nearly equal to the maximum capacity of the high pres-

sure engine. Therefore it was necessary to replace it with a much larger one. A contract was made with the Morgan Iron Works for the construction of the south engine, which was set up and put in operation July, 1857. This engine was similar in construction to the condensing engine previously referred to, with a steam cylinder of sixty-inch diameter, stroke of ten feet, two single acting pumps, each forty-inch diameter, six and one-fourth feet stroke. Much difficulty was experienced in preparing a foundation for this engine, as a portion of the only pump-well then built, from which the city supply was pumped, as well as the site of the old high-pressure engine. was to be occupied. However, the high-pressure engine was moved to a temporary site, where it might be used until the new works were ready. The labor of setting the stone was carried on during the night only. While constructing the foundation, no water could be admitted to the well, which seriously retarded progress. The daily supply of water was uninterrupted, and the reservoir in the South Division kept full, so that in case of fire the water therefrom might be admitted to the mains. In the summer of 1857 a twenty-four inch main was laid from the pumping works to the West Division, crossing the river at Chicago avenue, by means of a wrought-iron pipe. Soon after it was completed, the river-portion was rendered useless by a pile twelve inches in diameter being accidently driven through it, permitting the water to flow into the river. From this accident the engine narrowly escaped injury by the sudden reduction of load. The damaged pipe was taken up, repaired and placed in its original position.

Up to 1857 two engines had been built by the North Side pumping works. The first one, that of 1853, was put in operation December 16. It had a capacity of seven and one-half million gallons every twenty-four hours; steam cylinder, forty-four inches in diemeter, nine feet stroke; length of working beam, thirty feet; weight, nine tons; diameter of fly-wheel, twenty-four feet; cost of engine and boiler, \$24,500. The engine of 1857 was put in operation in July; capacity, thirteen million gallons every twenty-four hours; steam cylinder, sixty inches in diameter; ten feet stroke; working-beam, thirty feet; weight, sixteen tons; diameter of fly-wheel, twenty-four feet; cost_of engine and two boilers, \$59,000. Some parts of the engine were made to conform to the conditions of the building. Owing to the position of the tower, the valve-gear or customary front of the engine was placed on the side, as it was deemed imprudent to cut the corner of the tower to admit locating the front in the usual place. In December, 1853, water was first pumped into the pipes to test them, and the first hydrant was opened on North Clark street, near the bridge. The first permits to take water from the distribution pipes were granted February 12, 1854, to residents of the North and West divisions. Pipes were tapped February 15, and water introduced into the buildings of the city for the first time.

Following is a table exhibiting the "finances" of the water-

works from 1854-57:

Years.	Cost of Work.	Operating Exp. & Int.	Revenue.
1854	\$393,045.32	\$38,128.51	\$26,808.50
1855	496,849.64	59,051.27	54,739.19
1856	641,509.93	73,087.23	76,806.36
1857	738,436.51	85,170.61	97,008.55

On May 1, 1857, the works were supplying seven thousand and fifty-three buildings with water, for \$85,012 per annum. May 6, 1861, the Board of Public Works was instituted.

EARLY EFFORTS AT DRAINAGE.

Those who have made a study of the subject, in opposition to the popular error, testify that the substratum of the soil upon which the City of Chicago is built, far from being swampy and miry, is remarkably solid. Too nearly on a level for the rain to run off, it must evaporate or soak into the soil. Almost uniformly, except near the lake, a rich, black loam of one or two feet or more is gradually mixed with clay until it becomes pure, or hardpan intervenes. Occasionally a bed of quicksand occurs, rendering piling requisite for a sure foundation, but probably no other city ever arose where the ground was so perfectly adapted, by nature, to solid building. While groping after a good drainage system, in early days, the authorities made two mistakes. At first they attempted to dig down the streets, and construct crude sluices to carry off the surface water; next an effort was made to lay pavements and sewers upon the natural surface, or rather to let the drainage and sewage run along the gutters of the streets. Going more into detail, it is found that on February 16, 1847, the Legislature in an act supplementary to the charter gave the Common Council power to make and repair all sewers in the city. When, in 1849, the city virtually discarded stone pavements and commenced to plank the principal streets, the Common Council adopted a series of grades by which it was hoped to drain the surface as well as pave it. It was thought to be practicable in determining the grades to effectually

drain the lots contiguous to the streets by digging down the latter some eighteen inches beneath the common surface. Most of the planking of 1849 was upon that plan. Randolph, Lake and South Water streets were excavated, the grade ascending from the South Branch eastward to State street, which was to form the summit-level from north to south. Madison street was determined upon as the summit-level for all grades running toward the main river and in the opposite Randolph, Lake and South Water streets were therefore cut down to conform to these grades. The object was to drain the South Division from State street into the lake on one side and into the South Branch on the other, and from Madison street into the main river on the north, and to some yet unestablished east and west line on the south. Fortunately the Council confined their experiments for the first year to the three streets named. Before one month had passed by after their completion, the plan was regarded as a failure, and the attempt to make streets answer the purpose of sewers was abandoned. In 1850, State, Clark, LaSalle and Wells streets were planked, mostly upon the natural surface, with only such grading as was found necessary to carry off the water that might fall upon it. The main sewers were constructed in Clark, LaSalle and Wells streets, running through their centers from the river to Randolph street. They were built of heavy oak plank, triangular in shape. Their length was one thousand feet each; the side sewers being nine hundred and sixty-seven feet. The sum of \$2,871.90 was thus expended, and the property was specially assessed to the full amount of the cost. But although these improvements were in the march of progress, there was a determination among the far-seeing to look upon them as merely expedients. formation and perfection of a system was demanded. following extract from the Gem of the Prairie, of August, 1850, illustrates the advanced ideas:

"To any intelligent person going about our city, who understands the physical condition of health, and the causes which, with mathematical certainty generate disease, the wonder is not that we have had cholera in our midst for two seasons in succession, and that the common diseases of the country are fatally prevalent during the summer months, but that a worse plague does not take up a permanent residence with us. Many of the populous localities are noisome quagmires, the gutters running with filth at which the very swine turn up their noses in supreme disgust. Even some portions of the planked

streets, say, for instance, Lake between Clark and La-Salle, are scarcely in better sanitary condition than those which are not planked. The gutters at the crossings are clogged up, leaving standing pools of an indescribable liquid, there to salute the noses of passers by. being no chance to drain them properly, the water accumulates underneath the planking, into which flows all manner of filth, and during the hot weather of the last few weeks, the whole reeking mass of abominations has steamed up through every opening, and the misama thus elaborated has ben wafted into the neighboring shops and dwellings, to poison their inmates. Such being the state of facts, the people naturally expect the corporation will do something to abate the universal nuisance, or at least make the attempt to do so. But what has been done? Lime has been distributed to some extent, but in insignificant quantities, and some of the worst localities have * * Here is a long bill of been entirely neglected. complaints to prefer in the ears of the city fathers, which for the future welfare and honor of the place, we hope they will take into serious consideration. The evil. though great and increasing, is yet susceptible of a remedy. The only condition of health and decency, is a regular, thorough system of drainage. Such a system is feasible, and must be adopted if the 'Garden City' is to be habitable. It may and probably will cost \$30,000 or \$40,000 to begin with, on an extensive scale, and eventually \$100,000 or more; but what is such a sum in comparison with salubrity of atmosphere and health?"

The last attempt of any magnitude which citizens made to drain a large extent of territory without working under a clearly defined system, was under the direction of Henry Smith, George W. Snow, James H. Rees, George Steele, H. L. Stewart, Isaac Cook and Charles V. Dyer, who were appointed commissioners under an act of the Legislature dated June 23, 1852. They and their successors in office were empowered to locate, construct and maintain ditches, embankments, culverts, bridges and roads, on any lands lying in Townships 37, 38, 39 and 40, in Ranges 12, 13 and 14, Cook County; and to take land and materials necessary for these purposes, and to assess the cost of such improvements upon the lands they might deem to be benefited thereby. Their examination showed the commisioners that a vast body of land (more than one hundred and fifty thousand acres), within the limits of the commission which had before been deemed worthless, lay, in fact, from four to twelve feet above the lake, and needed only proper drainage to make it available for purposes of agriculture and occupation. When the commission was first created, objection was made that its powers were too great, and a fear was expressed that the proposed reform would develop into a stupendous speculation—even into a gigantic peculation. But subsequent events showed that such fears and suspicions were groundless. Within two years the commissioners expended \$100,000 in authorized improvements, with the most praiseworthy results. Large tracts of land were redeemed from the swamps and made valuable, and people were able to live comfortably, in dry houses, in localities which previously were thought to be uninhabitable. The lands drained extended four miles north, five miles west and ten miles south of the city. The ditches were mostly laid upon section lines, and parallel, draining into the Chicago and Calumet rivers. The Democratic Press in its annual review of 1854 has the following:

"There are within the city four and half miles of sewers put down at a depth of from five to eight feet below the surface. These extend along our principal streets, in the business portion of the city, and so far as the removal of surface water is concerned, answer, so far as they go, a complete purpose. This may be inferred from the facts already stated in regard to cellars, since a cellar without a drain is only a pool or an eel pit. Beput down, no fore these sewers were could be dug either upon Lake or Water streets, except in the driest of seasons. There was never perhaps, a city with features better fitted for drainage than this. The peculiar shape of its river, with its two branches, gives easy and short access to it from every section of the town; while there is, from every square rod of its surface, a gradual and sufficient inclination to the adjacent bank. The sewers only need to be extended as they have been begun to render the town as dry as is desirable. As they are, however, of a temporary and experimental make, if they are also to be made channels of the filth of the town, they will require to be laid in a more permanent manner."

By the act approved February 14, 1855, a board of sewerage commissioners were incorporated, consisting of one member for each of the three divisions of the city, to be elected for two, three and four years. It was their outy to consider all matters relative to the thorough and systematic drain-

age of the city; to advertise for plans and receive written objections, for thirty days; to report a plan to the Common Council with estimate of the necessary amount to complete it; to issue bonds, purchase lots and erect buildings, and appoint a secretary and treasurer. E. S. Chesbrough was appointed chief engineer, and insisted, from the first, upon the advantage of a high grade for the purpose of proper drainage and dry streets. The grade at last fixed upon was lower than he urged, but still sufficiently high to alarm the Common Council, who ordered a general extension of grades. By the system then in vogue about one-half the drainage from the South Division, all from the North Division except from establishments immediately along the lake, and all from the West Division ran into the river. The dividing ridge in the South Division was along State street, the water to the east of that line running into the lake. It will thus be seen that the river was the receptacle of all the drainage from packing houses, distilleries, and most of the hotels, business blocks and dwellings of the city, so that constant streams of filth were pouring into it, On December 31, 1855, Mr. Chesbrough made a report to the Common Council, stating that the commissioners had already decided that the plan of sewerage to be devised should "cover at present, the territory included within Division street on the north, Reuben street on the west, North street on the south, and Lake Michigan on The plan of draining the sewerage into the river and branches directly, and thence into the lake, had been decided upon as being less expensive than draining directly into the lake. In order to keep improper substances out of the sewers, it was proposed to introduce a slight but constant current into the mains, and to resort to flushing or cleansing by The sewers in the South Division were to have their principal dividing or summit line, on State and Washington streets. Starting from these dividing lines, they were to discharge westwardly into the South Branch, between North and Washington streets, northwardly from Washington street into the main river, between Market street and the lake, and eastwardly into large mains on Michigan avenue, one of which was to empty into the river, and the other have its outlet in the lake, on Twelfth street. Small branch sewers were to run through the streets, which lie parallel with the summit lines, so that every lot might be reached. In the North Division, three main lines extended from Division street to the main river, and had their outlets on Rush, Clark and Franklin streets, respectively. He also proposed a main having an outlet into the North Branch, on Chicago avenue. All the intermediate streets between the mains, and those running east and west, it was proposed to drain by branches of different sizes, so that every lot might be reached the same as in the South Division. It will be observed that no sewer had its outlet into the lake in the North Division. In the West Division mains from Reuben street to the South and North branches were proposed. For the present it was recommended that they be constructed only in Prairie, Randolph, Monroe and Van Buren streets, and in these only as far as existing improvements might require them. The streets and parts of streets intermediate between the mains, were to be drained by branches as in the south and north districts. With regard to the outlets of the sewers it was recommended that they be so placed that the bottom of the interior surface of the mains would be six inches above the low water level of 1847; and to place the bottoms of the two-feet sewers, six inches higher, or about the level of the present surface of The estimates made did not cover the sewerage for all the territory embraced in the plan, but merely so much as was considered necessary for present purposes: South district, \$157,893; north district, \$156,522; west district, \$188,-831. In the winter of 1856-'57 Mr. Chesbrough, upon the order of the board, visited some of the principal cities of Europe for the purpose of examining the various methods of sewerage adopted there, with a view of perfecting the system of Chicago. He recommended the system of intercepting sewers as the most feasible, the discharge to be into the lake at some point in the southern part of the city. With the idea of inaugurating the system the first sewers were constructed in 1856-a total of six and two one hundredths miles. the next year four and eighty-six one hundredths miles were built, making a total of about ten and four-fifths miles included in the sewerage system in 1857.

THE RIVER CONDITIONS.

Very early in the history of Chicago the attention of citizens was called to the sluggish nature of the river, and ordinances, were enacted by the town and municipal authorities against polluting its waters. The first measure was passed November 7, 1833. The ordinance of August 5, 1834, under the impetus of the cholera scare, was more stringent. Although the town and city authorities intended to be severe in times of epidemics, or when scourges were feared, very many

offensive substances did find their way into the river at all seasons of the year, and by 1845 the stream became terribly offensive, in consequence of blood and other refuse from slaughter houses being thrown into it. When that nuisance was abated, however, the odors of the "melancholy and slow" stream became comparatively bearable for some years. When the board of sewerage commissioners adopted Mr. Chesbrough's plan of draining directly into the river and its branches (in December, 1855) the public became alarmed lest this should endanger the city's health, and also fill up the river so as to obstruct navigation. Mr. Chesbrough discusses these objections, and explains his plan as follows:

"It is proposed to remove the first (objection) by pouring into the river from the lake a sufficient body of pure water to prevent offensive or injurious exhalations, by means which will hereafter be described. The latter objection is believed to be groundless, because the substances to be conveyed through the sewers to the river could in no case be heavier than the soil of this vicinity, but would generally be much lighter. While these substances might, to some extent, be deposited there when there is little or no current, they would, during the seasons of rain and flood, be swept on by the same force that has

hitherto preserved the depth of the river."

In speaking of the steamboat canal project, he says: "If it should ever be made for commercial purposes, the plan would be about as well adapted to such a state of things as it is to the present, making it necessary to abandon only the proposed method of supplying the South Branch with fresh water from the lake, and to pump up from the canal, or draw from the Desplaines directly, flushing water for the West District instead of obtaining it from the present canal at Bridgeport, as herein recom-For the purpose of keeping the water in the South Branch fresh, it is proposed to construct a canal, twenty feet wide and six feet deep at low water, between the lake and the South Branch, through North street (Sixteenth), and for the purpose of purifying, as much of the North Branch as possible, it is believed that the necessary canal should be located as far north as Center street."

By reference to the history of the sewerage system, it will be seen that the first sewers were constructed in 1856. During the next spring occurred the freshet which increased the depth of the river two feet, sweetened its waters, and destroyed, for a time, the apprehensions of sensitive people.

EXTRACTS FROM ANDREAS HISTORY OF CHICAGO.

Vol. II.

Sewerage System.

Previous to the organization of the Board of Public Works. about 54.5 miles of sewerage had been constructed-6.02 miles in 1856; 4.86 miles in 1857; 19.29 miles in 1858; 10.45 miles in 1859; 13.07 miles in 1860; and .53 miles in 1861. Although but 2,826 feet were constructed in 1861, three-fourths of this amount was built by private and interested parties. board had no resources from which to draw, and suit was commenced against the Sewerage Commissioners for \$58,-882.84, on orders which the Marine Bank refused to pay at par, and for \$107,746.53 against S. Lund, treasurer of the late board. In 1852, about three miles of sewers were constructed, principally of brick. The balance of the account due from S. Lund, now found to amount to \$108,696.53, had not been obtained. After the year 1863, when the finances of the city were somewhat embarrassed, the construction of sewers and the growth of the system progressed favorably. Following is a table covering the period, commencing with the time the Board of Public Works assumed charge, up to and including 1871, the figures for 1861 being the number of feet constructed up to that year, with cost:

Vear.	Feet Built.	Cost.
1861	283.586	\$660,188.40
1862	2,856	3,617.31
1863	15,676	57,264.51
1864	39,605	
1865		07 001 40
1866	29.948	137,643.02
1867	10 108	225,564.53
1868	89.661	416,730.51
1860	47,841	197,152.92
1970	139,705	004,141.20
1971	78,166	258,664.70
1011		

Totals.....800,192 ft. \$2,872,487.99

or 151 288/528ths miles.

The damage to the sewerage system, by the great fire was comparatively light, consisting of injury to manhole and catchbasin covers, and in the extra expense occasioned in cleansing sewers and basins, caused by the deposits of lime and debris from burnt buildings. The loss in this department is estimated at \$42,000.

The Water System-The Lake Tunnel.

The early settlers of Chicago were ever gazing toward Lake Michigan as the source from which, as a people, they were eventually to be saved from the vileness of their then water "privileges." Up to 1858 they had not gone more than a few rods from the shore; nor did they make the attempt for some years thereafter. It seemed to slowly dawn upon the municipal authorities that, as servants of the public, they were called upon to look to the quality as well as the quantity of the drinking supply. Two new reservoirs, each having a capacity of half a million gallons were erected in 1858. one being placed in the North and one in the West Division of the city. During that year the average daily supply was three million gallons. For several years the operations of the old works were uniform and satisfactory, except at periods during the coldest weather, when vast quantities of fish and ice collected at the mouth of the inlet pipe and threatened to cut off the supply entirely. The Board of Water Commissioners, having met the immediate wants of the community as to quantity, now began seriously to consider the question of purity of the water supply. Surveys and estimates of various improvements were made.

During 1860 five plans were submitted to the Council for attaining the requisite purity. First, by extending a pipe one mile out into the lake; second, by building a tunnel one mile under the lake; third locating the pumping works at Winnetka; fourth, by the construction of filter beds; fifth, by the erection of a subsiding reservoir. The suggestions did not receive much attention, but the people continued to cry for the purest water which could be obtained. The next year (1861) E. S. Chesbrough, as the newly appointed city engineer, submitted to noted chemists a number of samples of water, taken from the lake and river. One fact was ascertained which, at first, gave rise to some surprise, viz.: that water taken from near Clark street bridge, in the spring, was found purer than that taken from the lake, one mile from Cleaverville. was afterward explained, on the ground of "freshets." The investigation continued from early in the spring to late in the fall, and the fact was demonstrated that the water of Lake Michigan, some distance from the shore, was superior in every respect to that used by any other city, and could not be excelled.

EXTRACTS FROM ANDREAS HISTORY OF CHICAGO.

The Gordian Knot.

Vol. III.

The great problem ought to be solved in connection with the sewerage system of the City of Chicago, was the cleansing of the bed of the Chicago River of sewage sediments and local impurities, without having the poisonous deposits washed out through the mouth of the river into the lake, and possibly contaminating the public water supply, which is taken from the bottom of the lake, three miles distant from the shore. To this end, all operations have had in view the changing of the natural current of the South Branch of the river so that it shall set down the Illinois & Michigan Canal instead of flowing toward the lake; and continuing the waters of the North Branch past its junction with the main river down to the canal outlet. For this purpose immense pumping works have been erected at Fullerton avenue, on the North Branch, intended to force water from a lake tunnel into the river basin, thereby creating a strong current to the south; and twin pumping works have been erected in Bridgeport, at the entrance of the canal, on the West Branch of the river, which takes the polluted water from the river and pours it into the supplementary basin of the canal, thus creating a vacuum in the river and inducing a strong current in a southerly and westerly direction.

The operations of the dual pumping works have been measurably successful, and are adequate, perhaps, for ordinary seasons; but whenever a freshet sets in, it is invariably the case that the country on the line of the Desplaines River, from Chicago city line all along the river valley, from twelve to twenty miles distant, is entirely submerged, the water often covering an area of twenty or thirty square miles. the vicinity of Twenty-second street, during a heavy freshet, the water in the West Branch of the river not infrequently rises six or eight feet, while in the basin of the main river, north of Van Buren street, the rise is generally from eighteen inches to two feet. During the prevalence of a freshet, and often continuing two or three days, not less than 150,000 cubic feet of water a minute empty from the Desplaines River into the West Branch of the Chicago River. The flow of water from the Desplaines is much greater now than in former years, primarily because of the clearing up and ditching of swampy lands and acres of marshy country that for years had been covered with thick underbrush; the removal of these natural obstructions affording the periodical rains uninterrupted course, so that a fall of rain which formerly was days in finding its way to the city, now sweeps

in upon it in a flood in the course of a few hours.

But the principal cause of the great influx of water is the existence of the so-called Ogden Ditch, an excavation dredged by the late William B. Ogden, in 1868, through his lands about twelve miles west of the city, for the purpose of draining the large area of the Desplaines valley, some twelve or fifteen square miles, which, previous to his excavation, was submerged nearly the entire year. The Ogden Ditch, or Canal, is twenty-five or thirty feet wide, and extends through Mud Lake, in a northerly direction, about two hundred feet; then makes a sharp right-angular turn to the east, and continues some three hundred feet, forming a junction with, and emptying into, the West Fork of the Chicago River. During the season of the floods, the Ogden Ditch overflows its banks, receiving drainage and surface water beyond its capacity for discharge. To offset the trouble, and regulate the disturbances created in part by the Ogden Canal and in part by the rapid flow of surface and drainage water, the city constructed, in 1874, on land acquired from Mr. Ogden, a rude dam of piling, on which was spiked heavy plank, and filled in with earthwork to a sufficient depth to withstand the force of water. The top of this dam was on a level with the adjoining lands, and was built across the east arm of the Desplaines, and parallel with the north angle of the Ogden Canal, and served to wall out, to some extent, the waters of the big ditch, the flood of the Desplaines River, and the surface water from the Desplaines valley on the west and south.

This dam has been of good service, and has accomplished all that was expected of it; but at the same time it has been, from the first, a bone of contention, and has stirred up the ire and provoked the animosity of the neighboring property owners, who wished their lands flooded in the fall and winter, that they might reap abundant crops of ice for commercial purposes, and who again desired their lands drained in the spring and summer, for the successful pursuit of agriculture, It was their custom for a number of years, therefore, when the spring rains commenced to descend, and there was a reasonable prospect of a freshet, to repair to the dam with axes and other aggressive implements, knock the planking from

the piles, tear up the earth-works, and permit the water to have free course into the West Fork of the Chicago River: then, in the fall, before the wet season set in, to again fill in the earth on the dam, replace the planks on the piles, and permit the land to be flooded through the winter, thus insuring for themselves an abundant harvest of ice. In 1885, the city put a stop to these practices, by constructing a new and permanent dam on the site of the original works, excavating to proper depth, laying a solid masonry foundation, and building up the facade of the dam with heavy blocks of stone; then filling in with rip-rap material and gravel to the width of twenty-five feet, sloping down to the water's edge, and constructing a solid roadway over the dam, completing a wall and approaches which can not be readily thrown down or penetrated.

Another cause for the great rush of waters in this locality, is found in the fact that the State, in 1871, purchased a strip of land thirty-three feet wide, about a mile west and parallel with the city dam, and constructed thereon a public roadway of stone, six feet high, through the low and swampy region, thus damming in the water on the south, which has

no egress save by one small watercourse.

The city acquired of Mr. Ogden the perpetual right to maintain the dam it located, and has the privilege of extending it south to where the Ogden possessions adjoin the land of Hon. John Wentworth, which it will soon be necessary to do. But beyond the Ogden line the city can not go, Mr. Wentworth absolutely refusing to sell, or to permit the dam to be built across his land to the banks of the Chicago River, some three hundred feet further south. As the city dam is raised only to the height of the adjoining land, which has always been a swampy district, submerged most of the year, it does not encroach upon property rights. The dam, however, would be far more efficacious if it could be raised a foot or eighteen inches; but in doing so the country to the west would be inundated for miles beyond the present outflow, and probably as far as Joliet, entailing much destruction, and making the city liable for extensive damages.

The Desplaines River is decidedly mercurial in its tendencies, being down today and up tomorrow. It will this week be nearly dry, so as to be fordable at many points, and a week later will be so swollen with rains and freshets as to overflow its banks and sweep everything before it. The early settlers of Illinois were accustomed to float down the Desplaines from points fifty to seventy-five miles up the river, boating it where the depth of water would permit, and dragging or carrying their boats through shoals and over dry

places.

Notwithstanding the existence of the city dam, it was found by actual measurement, that, during the freshet of April 20-22, 1885, the Desplaines River was so swollen that 123,757 cubic feet of water a minute found its way over the top of the dam, through the West Fork, into the Chicago River; while the volume of water coming down the North Branch of the Chicago River, derived wholly from the watershed of the northwest section, was 26,467 cubic feet a minute, causing a rise in the main river of nearly two feet, a portion of the water flowing east into the lake, and a smaller portion flowing south into the canal. Yet this fall of water was only about one-half the quantity which usually enters the city

during the height of the flood season.

The practical operation of the river sewerage is this: In the dry season, when the river and lake are low, and the water in the river is at a standstill or sluggish, the machincry of the Fullerton avenue pumping works, which forces water from the lake tunnel into the river, or reciprocally from the river into the lake, is utilized to swell the volume of water in the North Branch of the Chicago River, and creates strong southerly current; while at the same time the pumpin works at the head of the canal, at Bridgeport, acting in correspondence, lifts the black, dirty water out of the West Branch of the river and empties it into the supplementary canal basin, thus creating a vacuum in the river, and inducing a current from the north. The water in the canal, which is usually raised from six to twelve inches in consequence of the water pumped into it, is prevented from flowing back into the river and buffeting the southerly current, by a lock, built in the canal in 1884. The lock is constructed of timber, the walls being crib-work, composed of a 2 x 8-inch plank, laid flat, one on top of the other, spiked together and filled with broken stones. The lock chamber is two hundred and forty feet long between the gates, and nineteen feet wide. The floor is formed of 10 x 12-inch sleepers, bedded in the ground and covered with two thicknesses of two-inch plank. Outside the lock are waste-gates, thirty-eight feet high.

Frequently during the prevalence of strong easterly gales, the water in the lake rises from eighteen inches to two feet, and, flowing into the mouth of the river, raises it from twelve to eighteen inches, creating a strong southerly current down the South and West branches of the river, and also up the North Branch toward the Fullerton avenue pumping works. At such times, pumping operations are suspended at the Bridgeport works, the lock of the canal is thrown open, and the entire volume of water in the river, with the sewage filth and sediment, is washed down the canal, and its place occupied by pure lake water, while the filthy river water, forced up the North Branch, is pumped throuh the conduit into the lake. When the North and West pumping works are acting in correspondence, the Fullerton avenue pumping works deliver from the lake into the North Branch of the river 24,000 cubic feet of water a minute, while simultaneously the Bridgeport pumping works remove 60,000 cubic feet of water per minute from the West Branch, and deliver it into the canal basin, the reciprocal action creating a strong and effective current at all times, save when the river is swollen by a freshet and general inundation. At such times, every effort of engineering skill and mechanical invention has thus far proved inadequate to cope with the action of the refractory elements, and the entire body of water in the main channel of the river and its several branches and tributaries is swept into the lake.

Although the capacity of the canal which drains the West Branch of the river is comparatively small, and the current consequently moderate, still the volume of water carried off daily is by no means inconsiderable. The mean velocity of water entering the canal is 6.9 inches a second, the height of the water being eight-tenths of a foot above city datum, and the area of the cross-section of the canal 381.1 square feet, showing that the amount of water passing into the canal is 219.13 cubic feet a second, or 18,932,832 cubic feet every

twenty-four hours.

In order to give an idea of the extent to which the Chicago River serves as a common sewer, it may be stated that 7,097.33 surface acres drain into it, from ninety sewer-discharge openings, the area of these terminal openings aggregating 921.81 square feet. In addition, 1,270.43 acres in the South Division of the city drain directly into the lake. The water of the North Branch, from the rolling-mill south, is usually highly discolored, with a perceptible odor; of the main river, nearly free from deleterious matter, with little odor; of the South Branch, highly discolored, with considerable odor; of the West Fork of the South Branch, nearly pure,

with no perceptible odor; of the South Fork of the South Branch, extremely foul, charged with decomposing animal and

vegetable matter, and odor very offensive.

Whi'e the highest engineering skill obtainable has been brought to bear on the question of the disposal of the public sewage of Chicago, and while money has been spent lavishly in building the most improved machinery for rendering the river an available and efficient agent for this purpose, it must be conceded that thus far only indifferent results have been attained; and as the population of Chicago shall double and quadruple, it will be found imperatively necessary to push to

a successfull solution this perplexing problem.

The Fullerton avenue Conduit, which was completed and put in operation January 9, 1880, is a brick tunnel, circular in section, and twelve feet in internal diameter. It is 11,898 feet long from the lake shaft to the North Branch of the Chicago River, 4,270 feet at the bottom, from the river to Racine avenue, being level and 13 feet below city datum; while east of Racine avenue is a vertical reverse curve connecting the upper and lower grades, which at this point is 271 feet below datum. Thence the conduit continues by a series of descending grades to the lake shore shaft, where it is 541 feet below datum, the grade from this point to the lake shaft, a distance of 1,000 feet, being level. The west end of the conduit excavation was an open cut, while from Racine avenue eastward it was tunneled. The upper part of the lake shaft is a cast iron cylinder, 11 inches thick and 24 feet long, lined with brick, and having an internal diameter of 12 feet, the dimensions of the shaft below the cylinder being the same. The top of the cylinder is 41 feet below city datum, and is located in a wooden chamber, 34 by 18 feet inside, with openings on the east side into the lake, which are fitted with gates, to be closed only when the cover is on the shaft, and to prevent its being lifted or damaged by the violence of the waves. At this end the water is shut off from the conduit by a conical cover of boiler-plate iron, on the lower end of which is a strong inclined flange fitting on a corresponding flange cast on the top of the shaft, with a packing of rubber tubing between the two flanges, rendering the joint water-tight. The cover projects above the water, and an opening permits access to the shaft, which is protected from the turbulence of the lake by a pier of pile-work, securely braced together, filled to the water level with loose stones, and built so as to offer the least resistance to ice and storms. On the pier and over the shaft is a house, fitted with a winch for raising or lowering the cover of the shaft. The shafts at the lake shore (Larrabee street and Sheffield avenue) are twelve feet internal diameter, while at each intersection are shafts of six feet internal diameter. All shaft are carried up to the level of the street, are so arranged as to form ready connections with the sewerage system, and are domed over, with openings on the top for access, provided with strong covers and with ladder-irons.

At the river end, where the machinery is located, the conduit forms two semi-circular channels, passing on each side of a wrought-iron chamber, where the two channels are re-united, forming one channel of size and section uniform with the main conduit, and continuing to the outlet of the river, where it is protected by a heavy masonry dock wall, in which is placed a series of iron rods, to guard against floating debris entering the tunnel and obstructing the wheels when the current is from the river to the lake. The water is forced through the conduit by means of two screws similar to those of an ordinary propeller, one fixed at either end of a horizontal shaft forty feet in length and placed in the center line of the conduit, passing through a boat-shaped iron-chamber, ten feet in its greatest diameter. The shaft and screws are operated by two single-cylinder condensing engines, having cylinders twenty inches in diameter and thirty-inch stroke, with side-valves, cut off motion, and reversing gear, permitting the engines, which are placed on top of the chamber, to run either way, reciprocally. The driving-shaft is eight inches in diameter, and the engines are coupled to the middle or crook-sections by connecting-rods sixteen feet long, this section carrying also eccentrics for working the valves. screws are four-bladed, six feet and seven inches in diameter, with a pitch of eight feet, the blades being twelve inches in width. The total area of the four blades of each screw is equal to one-half the total area of a complete turn of the helicoid. There are three cylindrical boilers, sixteen feet long and sixty-six inches in diameter, with forty-five inch longitudinal tubes in each boiler. The boilers have thirty square feet of grate surface each, and one thousand square feet of heating surface, and are connected with a brick chimney three feet nine inches square inside and one hundred feet high. The boilers are calculated to stand a pressure of eighty pounds to the square inch, and the engines to work at a rate of one hundred and twenty-five revolutions a minute. The size and form of the screw are novel and without precedent, a propelling wheel having never before been used for the purpose of forcing water in a confined channel; but it has been found to work satisfactorily, and to perform the duty required of it with the greatest economy. With one hundred revolutions of the screw, a head of four feet is maintained in the line of the conduit, a force sufficient to deliver twenty-four thousand cubic feet of water a minute.

Careful observations, with experiments continuing through two days, gave results embraced in the accompanying table, which shows the velocity of water in the conduit, measured at different positions with an electric current meter. Diameter of the conduit, twelve feet; length, eight thousand nine hundred feet between stations; obstructions to flow, sixteen shafts of six feet diameter, two shafts of two feet diameter, two bands of forty-five feet radius; angle, thirty degrees.

It is interesting to note that the current through the conduit is induced with the same power when discharging into the river as when discharging into the lake. It has been demonstrated that, in pumping lakeward, the machinery does not actually displace and force before it the volume of water contained in a mile of conduit of twelve feet diameter, but that, instead, a whirling or screw-like motion is given to the water in the conduit, which obtains an edyying current through its entire length, similar to the motion given to a conical shot discharged from a rifled musket. So strong does this current become, that if the engines of the pumping works are shut off, the propeller screws in the chamber of the conduit continue in motion several minutes.

The original cost of these works was \$564,253.99. During May and June, 1882, new wheels, eight feet in diameter, were put in the conduit, materially increasing both the power and

the efficiency of the works.

During 1884, the pumps delivered the water mainly from the river into the lake, 5,175,000,000 feet being forced in that direction, as against 1,238,000,000 feet from the lake into the

The cost of operating the works during the year was \$20,-The effect of pumping from the lake into the river was unsatisfactory, the water in the North Branch quickly becoming foul, and fermenting, and in the main river, in three or four days, during the summer solstice, becoming very offensive, even while the pumps in the South Branch were in operation.

The propellers were operated almost continuously during

1885, usually with sixty revolutions per minute (about half their capacity), with about the same result as in previous years, excepting that the volume of water passing through the conduit was poured into the river, instead of being emptied from the river into the lake. Early in the year, the framehouse over the lake terminus of the conduit was burned, the debris falling into the mouth of the conduit. The smaller pieces of timber from time to time passed through the conduit and wheels without detriment, but in the summer, a shock was sustained by the machinery, and it was found that a solid oak timber, four feet long and twelve inches square, had wormed its way through the blades of both screws without occasioning any perceptible damage. In November a second timber, five feet long and a foot square, presented itself to the propeller wheel, stripping the four blades from the first wheel and two blades from the other wheel. This necessitated the shutting down of the works for two weeks. The influx and efflux gates were closed, a diver was sent into the conduit to remove the timber, the water chamber was pumped out, and

new wheels were substituted for those broken.

The Canal Pumping Works, at Bridgeport, were completed and put in operation in 1883. The building is located across the old channel of the Illinois & Michigan Canal, two hundred and sixty-five feet west of the South Branch of the Chicago River. The influent channel is sixty feet wide, dredged to a depth of ten feet below city datum, the sides being vertical and maintained by a strong timber dock. The effluent channel is excavated to a depth of six feet below city datum, the side slopes being paved with stone. The machinery consists of four sets of pumps, each set being composed of two centrifugal cataract-pumps placed in a dry-well below the surface of the water in the river, and driven directly by a vertical condensing compound engine, the high-pressure cylinder being eighteen inches in diameter, and the low pressure cylinder thirty-four inches in diameter, each having a stroke of thirty-four inches. The pump-wheels are of cast iron, six feet in diameter. Each pump is coupled directly to the engine crank-shaft. The engines are adapted for running at high speed. There are eight horizontal return tubular boilers, each six feet six inches in diameter, eighteen feet long, and containing sixty tubes, each four and one-half inches in diameter and eighteen feet long. The boilers are capable of sustaining a pressure of eighty pounds to the square inch, and are placed in two boiler houses, one on each side of the influent channel. Each set of boilers is connected with a nine-inch steampipe in the engine-room. The machinery has a capacity for raising sixty thousand cubic feet of water per minute to a height of eight feet, and develops a duty of forty-five million pounds of water raised one foot high for every one hundred pounds of coal consumed. The total cost of the works was \$268,000. The operations in 1884 resulted in maintaining the water in the South Branch of the river and in the canal in a satisfactory condition, besides improving canal navigation. The cost of operating the works during the year was \$32,584.78. The operation of the pumps had no effect on the water in the South Fork of the river, extending from the pumping works to Thirty-ninth street, and which is a general cess-pool for the accumulations of refuse matter from the stock yards This putrid stream is a nuisance, detrislaughter-houses. mental alike to the section through which it passes and to the city at large, and no effectual plan has yet been devised for cleansing it. The pumps have discharged the full volume of water that could be carried away by the canal without overflowing its banks, the quantity being about forty thousand cubic feet a minute, or about two-thirds the capacity of the works.

EXTRACT FROM A REPORT OF MAIN DRAINAGE COMMITTEE TO THE CITIZENS' ASSOCIATION 1880.

The Topographical Situation of the drainage district under consideration may be briefly described as a strip of land, in the eastern part of Cook County, varying in width from 7 to 10 miles, traversed by the Chicago River its whole length, which is about 40 miles; the only outlet of this River to the Lake is at the point where the City of Chicago stands, about 35 miles south of the source of the river, and 5 miles north of the southern most of its branches or forks; the outlet to the lake at Chicago has been widened and deepened and its course changed so that it opens nearly due east, is called the main branch of the Chicago River, and is at right angles to the principal streams which are called respectively the North and South branches. These branches have also been widened and deepened to meet the necessary requirements of commercial enterprise, so that vessels of from 10 to 14 feet draft can navigate with safety the River and its branches, to a distance 1 mile west from the entrance and 6 miles north and south, all within the city. The process of enlarging the River, at Chicago, has destroyed what little natural current

there ever was in it, and there is now no other than that caused by winds, the inflow of water from the lake, or a freshet caused by extraordinary rainfall or the melting of snow and ice in the spring. For the purposes of this Report the Chicago River may be described as a great ditch 6 miles long, with a projection from about the center one mile long. and the whole averaging about 150 feet in width and 10 to 15 feet deep; this ditch receives at its north end a small stream, (30 miles in length), the force of whose feeble current is neutralized by the increased width and depth of the channel it enters, and it has at its south end several forks or branches which serve to take off a small amount of water; there is also, from the south end, the Illinois and Michigan Canal, to which reference will be made hereafter. Into this huge ditch the greater part of the sewage and other drainage of the City of Chicago falls, together with the offal of the immense slaughtering establishments, situated in the adjoining Town of Lake, the refuse of the manufactories great and small, and to far too great an extent, that of the distilleries and their adjoining cattle pens. A part of the sewerage system has its outlet directly into the lake in front of the city, but that part is by comparison so small as to have no bearing on the main question before us, at this point of its consideration. whole geographical position is backed on the West by a ridge. which though of no great elevation, is sufficient to form a water shed of the greatest length given above, with the river running through it about equi-distant from the ridge and Lake Michigan; the land between the ridge and the lake traversed by the river is flat, and just where the city stands, is a little higher on the west bank of the river than on its East side, towards the lake; the natural flow of water from all points is towards the River and not to the Lake.

The Only Natural Means of flushing or scouring out this great ditch, is from the water during rains, which flows into it from the adjoining country, including that part bordering the northern projection, the freshet caused by the melting of snow and ice in the spring, and the overflow of the Des Plaines River, which sometimes swells over the low ridge referred to above, and comes in great and often destructive volume into the South Branch and so through the Main Branch of the Chicago River into the lake. Could this be relied on at all times, it might be so utilized as to relieve the drainage difficulty now before us, although it would necessitate some other plan than that we have adopted for our water

supply for domestic and all other purposes; it is, however,

unfrequent and undesirable.

The obvious consequences of this state of affairs is that at all times since the city adopted a system of sewerage, the River has been befouled with its discharges and accretions, for which there has been no natural remedies, except those of the occasional character mentioned above. As the population increased this befoulment became more marked, and in time so unendurable that relief of some kind became imperatively necessary, as, although the pumping works at Bridgeport, originally erected in 1847 for the purpose of supplying water to the Illinois and Michigan Canal had been utilized for the purpose of cleansing the river to the extent of their capacity, that system was found to be very inadequate for the object, and after 5 years work the Canal was widened and deepened so that in 1871 it was opened for the inflow of the Chicago River, amidst public rejoicings, and there was a sanguine belief that our drainage troubles were at an end. It was soon found that these anticipations were doomed to disappointment; the depth of the canal after enlargement is about 8 feet less than that of the River, and the sides were cut down at an unfortunate angle, making them too steep or upright; the consequence has been that the water flowing from the lake to the canal, through the river, has only cleansed that portion of the last which was 5 feet above the bottom, there being a recoil at the miter sill of the canal, of the water below it, and a backward current of greater or less power according to circumstances; besides this, the canal began gradually to fill up from the sediment carried into it from the river, and from the deposits naturally coming over the sides, thus decreasing the depth and the capacity for taking water from the river; at about this time, (1871) also, the Lake began to fall, as it is known to do at periods, diminishing the volume of water in the river. The net result of all these causes was soon apparent. It was seen that by deepening the canal we had only lengthened the ditch which we call the Chicago River, and that after the canal had been filled, it was, with such relief only as is obtained by opening the locks for the passage of vessels or other purposes, fast becoming as foul as the river itself, to the unmitigated annoyance of the inhabitants along its line; and it was the subject of their loud protest. Nothing can keep it even moderately clean but constant dredging, rendered more expensive from the very fact that it has been deepened.

Some other means of cleansing the river was demanded.

and the Fullerton Avenue Conduit was projected, to scour the river by pumping from the lake, or, vice versa, to create a current through the main river, up the north branch, and so out into the lake, flushing the south branch as a collateral measure by the natural process of displacement or suction

which would follow.

It were profitless to attempt to detail the various annoyances the public have been subjected to during these many years they have been waiting for some plan of relief for their sufferings from the foul condition of their principal sewer, which unfortunately for the purposes of drainage, is also a navigable river; an overflow of the Des Plaines or a freshet from any cause has been hailed with something akin to delight, and a easterly storm by driving in the water to dilute and carry off part of the filth has been looked upon as a blessing.

We have arrived, in this report, at that period of time, (February and March, 1880) when, while the Fullerton Avenue Conduit is in full and partly successful operation, the public meetings referred to above were held with the view

of a free discussion of the whole subject.

In addition to the facts hereinbefore stated, some others having a very important bearing on this question were brought to light, the principal one being that which relates to the operation of the Fullerton Avenue Conduit, which had at that time been sufficiently tried in one direction, that of sending water from the lake into the river, and so out by the main branch into the lake again, to develop the danger there would at all times be of fouling the water supply for domestic purposes: the experiments made for the purpose of ascertaining such a probability, demonstrated conclusively that a very considerable quantity of the filth discharged from the mouth of the river found its way back into the water pipes, and further investigation has shown that except under favorable conditions this will always be the case, as the contents of the river will not, all of them, mingle immediately with pure water, and be carried away by any current that may be caused by winds, favorable for the purpose, but for a long time will float about the lake in a semi-isolated mass, subject to the effect of such winds and currents as may strike them, and always liable to run into the tunnel at the crib; and for this reason, that there is always there an effective current for a considerable distance in every direction, around and tending towards the crib. It was shown also, that temporary relief could be obtained by the immediate re-erection of the pumping works at Bridgeport, and it is believed that with the aid of the Fullerton Avenue Conduit, these pumping works at the entrance of the Canal will afford such a measure of relief as will enable the city to get along with moderate annoyance for five years or so, or until some better system has been brought into operation. The immediate re-erection of those pumps, was, therefore, the recommendation made by our Committee, through you, to the municipal authorities, as a temporary expedient, and the money having been appropriated by the Council for the purpose, the action of the City Executive is awaited with becoming patience.

Review the topographical situation as hereinbefore given, revise the meagre history of the attempts to purify the river, consider the feeble means now in operation and those necessarily temporary adjuncts looked for at an early date, and to these considerations add the probability that the drainage district we have contemplated is to be the home of 2,500,000 people within the period of existence of many now living, and you have before you the drainage problem as we

understand it.

We present to you and the public a proposition or plan for an independent cut for the drainage of the district to which we have heretofore alluded, the details of which are embodied in the following report, from the well known and competent engineer whose name it bears, whose services you placed at our disposal, for the purpose of making the estimates, and drawing the map and profile accompanying it, reduced copies of which we append hereto, and the originals of which are on exhibition at your rooms in this city, for inspection of the public.

Such is the plan proposed for the drainage of Chicago, which, it is believed, will accomplish the object desired for

all time to come.

To complete it, however, the sewers discharging into the lake will have to be reversed, and made to empty into the river, as also, the local drains in the adjoining towns north of the city, as far as the source of the Chicago River, and those of Hyde Park. The towns of Lake and Cicero will also come within the drainage district herein proposed. In reversing the city sewers, such a fall should be made as would carry the lake water through them, thus cleansing and rendering them inoffensive at all times. The Fullerton Avenue Conduit could remain as it is, or its tunnel could be utilized

for additional water supply. An intercepting sewer can be

built if needed.

The forks and branches of the river at the south end of it will purify themselves, as their contents will gravitate towards the current created by the outflow of water to the cut or New River, as it may be called for the purpose of description. The current in this New River will be at the rate of about 2.15 miles per hour; the water in Chicago River will be changed every 24 hours, with One Million of cubic feet over, and the whole body of it within the city limits, will be by this operation, become as clear as that of the lake; the effect upon the waters at its point of discharge, will be to greatly improve them in every respect.

REPORT OF THE COMMITTEE ON MAIN DRAINAGE AND WATER SUPPLY.

Chicago, Aug. 27, 1885.

To the Executive Committee of the Citizens' Association:

The undersigned committee appointed for the purpose of investigating the subject of Main Drainage and Water Supply of Chicago, begs leave to submit the following report:

A problem of the first magnitude is presented in the main drainage of a city of 700,000 inhabitants, with the immediate prospect of a population of 1,000,000, and a growth of 2,000,-000 within the life-time of citizens who knew Chicago as an Indian trading-post. That the city should have attained this growth without the development of an adequate official plan, for a permanent system of main drainage would be startling in this day of sanitary science, were it evident that the conditions of the problem had ever been properly apprehended. The sanitary history of Chicago is a history of makeshifts and expedients, in which official provision has scarcely ventured beyond corporate limits to the consideration of the drainage basin of which the municipal area is but a small Even those expedients which, while involving a moderate expenditure for the relief of the present situation, might still be in harmony with a general plan, seem to be inadequately realized, or quite misapprehended.

Chicago, in regard to her water supply and main drainage, is perhaps, more fortunately situated than any other of the principal cities of the country, except those on our large rapidly flowing rivers, which carry away the sewage at once, a condition which may here be readily duplicated. Cities on

tide-water or minor streams, with much less population and having problems of greater difficulty to deal with, have not hesitated to make far greater expenditure, in proportion to their resources, than is required here for measures of permanent relief. They have considered it wise, before the public health was menaced, to call in the most eminent experts to consider the problem, with a view to the best solution that the conditions permitted. They have even regarded large expenditure in the collection of data and in exhaustive preliminary study as a measure of undoubted wisdom.

Your committee has been able to give to the subject only a few weeks of special observation and study. Its sources of information are accessible to any citizen who chooses to investigate the matter for himself. Cognizant of the facts of our sanitary history, it is a matter of no great difficulty to define present abuses, to point out measures of relief and to suggest a general plan for the permanent solution of our drainage problem, as a matter for popular discussion and expert con-

sideration.

Pollution of the Water Supply.

In the great rain of August 2 of this year, the contents of both branches of the Chicago river, with the sewage accumulation of many weeks in the South fork, the contents of slips, and the flushings from several hundred miles of low-grade sewers, were, in a few hours, incontinently belched into the lake. At every considerable freshet in the Desplaines and in the North branch, or several times in an average season, a similar obnoxious flood, differing little in degree, is turned lakeward. At other times the flow from the Desplaines is quite sufficient to supply the canal, and the South branch is left in a stagnant condition of accumulating putridity, ready to take its way to the lake on slight occasion. Your committee found the South branch in bad condition a week after the great storm, and within ten days the South fork was pestilential—a seething, bubbling mass of decomposition, exhaling the most noisome odors.

The ejection of such volumes of sewage into the lake at irregular intervals, is a matter for most serious consideration in connection with the water supply. That it sometimes reaches the crib under favoring conditions of wind and current is a matter of direct observation and evidence from city hydrants. That it sometimes extends southward to the Hyde Park supply is also ascertained. Even the comparatively small discharge from the Fullerton avenue conduit has given

evidence of pollution when no other sewage was entering the lake. Recently the discharge from this conduit was observed in an unbroken stream for over a mile south and parallel to shore, and again in a similar position to the north, to the well-grounded alarm of the people of Lake View. That raw, unoxidized sewage occasionally and not rarely contaminates our drinking-water, does not admit of serious question.

((Foot-note a): On Wednesday, August 5, the river discharge was observed in an unbroken stream to and around the crib. Chemical and microscopical examinations of the water, collected under different conditions, are appended to

the Supplementary Report.)

If we suppose the entire sewage of Chicago for one weekand such accumulation is sometimes greatly exceeded-to be turned into the lake at the mouth of our harbor and uniformly distributed through the water for four miles into the lake and eight miles along the shore, each 200 gallons of water would contain one gallon of sewage. Sanitary authorities variously estimate the dilution required to oxidize sewage beyond offense at twenty to one hundred times. As this oxidation reouires time, no argument is needed to make it apparent that, in the general diffusion of the contents of our river through the body of water off-shore, partially oxidized sewage reaches the crib. Even though we admit the complete oxidation and diffusion of sewage through the waters off this shore, sanitary science would hardly commend the domestic use of oxidized sewage, nor will the average citizen feel reassured at the admixture of a half-gallon thereof in his daily water supply. (See microscopical and chemical examinations in Supplementary Report, pp. 22-32.)

The tendency, however, of streams of different specific gravity and constitution is to remain isolated, or to diffuse slowly, as may be observed where any stream debouches into a body of water, or where two rivers unite. For this reason a large sewage discharge may remain off our shores unoxidized for a much longer period than if we could suppose it rapidly and generally diffused. The danger from sewage contamination would thereby be greatly increased and of oxidized sewage in

no wise lessened.

While the occasional admixture from sewage is beyond dispute, and the presence of oxidized sewage is probably far more frequent, the determination of any well-defined current that may prevail in the lake off our shores would be a matter of great interest. So far as the observations of your committee extend, they go to show that the surface current is

most largely a matter of direction of wind, and is accompanied by a counter-current near the bottom; so that with a stratum of sewage-water beneath, mere surface observation is not sufficient to determine the direction or extent of its movement.

It is obvious that if sewage is allowed to debouch into the lake at all, freedom from risk of contaminating our water supply can only be secured at great expense—far greater than would be required to permanently dispose of the sewage in

some other direction.

The South Fork.

That this branch has been allowed to continue, from year to year, in an abominable condition of filth beyond the power of pen to describe, is one of the anomalies of our municipal history. Flushed only during periods of heavy rainfall, its contents inevitably find their way to the lake. Its highly offensive condition is most largely due to the extensive packing establishments, and the industries incidental thereto. As this is a special class of sewage, it would be fair to demand chemical precipitation, or other treatment equally effective, thus removing at once a large, and the worst, proportion of putrescible matter. Measures of permanent relief should be instituted at an early day. Several plans for regularly voiding the contents of this fork can be suggested. One of the best would seem to be a pumping station and a conduit on 39th street to Lake avenue, on Lake avenue to 56th street, and along 56th street to the lake, thus furnishing a proper outfall toward the South fork for the sewerage of the northern portion of Hyde Park, which is naturally tributary to the Chicago district. The opening of a navigable channel along 39th street is also worthy of consideration; a channel that may be demanded in the interest of permanent bridges in the heart of the city, and also by the requirements of commerce in the southwest district whenever the National government may have developed ample water communication to our Western rivers. Incidentally, it may be said that the main sewers on 12th, 22d, and 35th streets, which now discharge into the lake, should ultimately have their outfall at the river—the natural elevation being sufficient for that purpose—and that no new outfalls on the lake front should be contemplated in the future.

The west arm of the South fork is the natural outfall of a large portion of the town of Lake, south to 60th street. Unless it is filled up or farther extended through to the canal, at

an early day, its proper cleansing will present a serious problem. Meantime, to drain into it the surface water naturally tributary thereto, and which has been diverted to the canal, would at times afford some relief.

Flood Dangers.

The treatment of the flood discharge is a far more difficult matter, but a question of much moment, aside from its relations to our sanitary problem. Old citizens will remember the great flood of 1849, and the destruction produced thereby, a flood that is liable to recur under exaggerated conditions with un-

limited capacity for mischief.

The Desplaines water-shed has been largely cleared up and water-courses opened, so that floods come more suddenly and in greater volume than in former years. There is liable to be an accumulation of from twelve to eighteen inches of water in the form of snow over this area, to be quickly melted by a warm rain, in a manner similar to the great Ohio river flood of 1882. If this be accompanied by an ice gorge in "Twelve-mile level," below Summit, as would be probable, this great flood would be precipitated through Chicago in untold damage. With no ice gorge, the result would be sufficiently disastrous.

It is unwise to argue that such danger is remote. All the conditions except the usual temperature and rainfall were fully satisfied in 1881. Fortunately, with an average temperature of 34 degrees, and a rainfall of only one-half inch during a period of twenty-one days, this great body of snow was gradually melted, not, however, without a long-continued large flood volume, attended with considerable damage. It is hardly supposable that nature would be again so considerate.

The necessary combination of circumstances has occurred too often at other localities to warrant the belief that Chicago will be definitely exempt, and she is built above no protecting

bluff escarpment.

Suggestions for a Permanent Solution.

Your committee has incidentally brought to light facts bearing on a solution of the drainage problem, which would appear to have been hitherto unconsidered. They are stated as suggestions to, and in argument for, a body of experts, which should be constituted without delay, to adequately consider the whole subject in full detail.

The general problem as it appears to your committee may

be stated as follows:

1. By keeping the sewage out of the lake, Chicago can avoid a nuisance on her shores and save, in future changes and extensions of her water-supply system, a large part if not the

whole of the cost of an adequate main drainage.

2. Experience has not yet developed any artificial treatment of sewage that does not involve a large first-cost and continual expenditure. The best of these, by the method of intermittent downward filtration, is not feasible for Chicago, on account of the great distance to proper land. Even were all the conditions properly fulfilled, some means would still be required for circulating the water in our rivers. In the possibility of disposing of the sewage quickly, by natural flow, and at far less cost, any plan of sewage treatment may be dismissed from present consideration.

3. The proper disposal of the sewage is unquestionably down the valley of the Illinois. It must be diluted to that point which will speedily produce a complete oxidation, or the growing populations along the river will not permanently tolerate

so insufferable a nuisance.

4. The contents of all channelways, into which sewage is discharged, should be changed so rapidly that no sewage will

remain within the city limits over twenty-four hours.

5. The drainage area, now tributary to the sewerage district, should be reduced as much as possible in order to avoid the variations of rainfall over large outlying districts, the danger of floods, and the liability of an occasional discharge of the contents of our channelways into the lake. The main drainage of Chicago involves the entire water-sheds of the Desplaines above Summit and of the North branch, and the region south to the general east and west line of 60th street, an area of nearly one thousand square miles. It has already been suggested that the North branch can be readily diverted to the lake from Bowmanville, thus reducing the area by over one hundred and twenty square miles.

An examination of the Desplaines river shows far greater capacity for many miles above Summit than below; in fact, for twelve miles below Summit the bed is a succession of pools, with rock bars, differing little in height, and retaining the water at a uniform level of about eight feet above Chicago datum. With a mile of bank only three or four feet above low water, and broken by frequent crevasses of one and a half feet opening out into the rapid descent of Mud lake valley, it must be evident that a large proportion of all flood-waters, above a certain minimum discharge, find their way to the lake. The entire flood discharge of the Desplaines can, without

doubt, be readily confined in a course to the south, but this is a course which it has never pursued, and such diversion of its natural flow would render the city liable for any resulting damages. Unquestionably the channel could be greatly improved so as to diminish this liability, and this might be expedient did not a better solution offer.

From an examination of the divide between Desplaines and the North branch, it is found feasible, at moderate expense, to divert the Desplaines near the south line of the town of Maine into the North branch at its westerly bend; thence following the North branch valley to Bowmanville and to the lake

through Lake View.

This diversion would dispose of from 75 to 80 per cent. of all the flood-waters of the Desplaines gathered from the watershed above Summit, besides the flood waters of the North branch as previously suggested. There will remain about 100 square miles, which may be called the Chicago sewerage district proper, and about 160 of the Desplaines, or 260, in place of about 1,000 square miles, to consider in a scheme of main drainage.

Assuming that an increased capacity of the canal is conceded as an essential in any scheme, your committee offers the suggestion that such enlargement be confined to the first eight miles, or to a point near Summit, at which the canal and the Desplaines are within less than a quarter of a mile of each other, and where they may be readily connected. A full consideration might show that from Bridgeport to Summit, the West fork and Ogden-Wentworth ditch route, would pos-

sess superior advantages.

For twelve miles below Summit, or until we reach Walker's quarry above Lemont, the water stands on a level about eight feet above datum, or less than five feet above present lake level. Throughout this reach there is much channel of twelve feet in depth and of ample width, and much more that would undoubtedly cut out to that depth under the influence of a brisk current. For only a small portion of this distance were rocky fords found, and it is believed that a full examination would not disclose a serious amount of rock excavation; so that channel may be produced here seven feet below present lake level, and not less than two hundred feet wide, for twelve miles, at comparatively small expense. For eight miles below Walker's quarry the channel would be practically in continuous rock-cut, the average declivity of this portion of the valley being about one foot per mile. Near Lockport it falls off rapidly to twenty feet below datum. It would seem from the examination thus far made that a channel of sufficient capacity can be made on this route for about one-half the cost of enlarging the canal, and this channel would be capable of future enlargement at moderate cost. This route can only be considered, however, in connection with the diversion of the flood-

waters of the upper river.

The duty of the new channel would be to take care of the natural flow of 260 square miles of territory and the sewage, properly diluted, of its population. It can be developed with ease into a great navigable channel, and furnish an ample water supply for the low-water navigation of the lower river from the most magnificent reservoir available as an aid to navigation, and make apparent the error of the opinion which led to the construction of locks and dams on the Illinois, below Peru. In an ample section, with all the depth and grade which could be given to a channel from Chicago to Joliet, the stream would be readily navigable, as experience has shown with much higher velocities on our Western and Southern rivers. If the project should ever be carried out with due regard to its possibilities as an aid to navigation, over one hundred thousand horse-power would be available between Lockport and Peru, the yearly value of which would represent a dividend on many millions of dollars.

The suggestion proposed has the merit of inviting expenditure for present relief in the direction of an ultimate plan, each step of which would be of substantial benefit. Thus, in a very few years, without the necessity of an increased indebtedness, a permanent plan may be carried out at a relatively small expense as compared to that of many of our cities. At the same time an important step would be taken in a proper project for connecting the navigation of the Great Lakes with that of the Mississippi river, which may be followed by the General government without suspicion that it is purely in the interest of

a local drainage project.

The solution of our drainage problem involves contiguous territory, many diverse interests, and a mature expert consideration, after the most comprehensive data have been collected. It would be rash to urge any project as the best in advance of the competent study which should be provided for, but in calling your attention to what appears to be a ready solution of the problem, it must be apparent that the matter has not hitherto been adequately considered.

Your committee would urge with all possible force the necessity of an expert commission to make the fullest investigation. The commission should be constituted for an ample

period, and be sufficient in number to give competent expert consideration to all phases of the problem and to eliminate purely personal views. To suppose that those charged with executive duties in a great city will find the leisure to adequately consider the matter would be to ignore our past history.

> Respectfully submitted, O. GUTHRIE. L. E. COOLEY, C. E., F. W. REILLY, M. D., WM. RUTHERFORD, CHAS. A. MACDONALD. DAVID BRADLEY, J. J. GLESSNER, EDWIN LEE BROWN.

Committee.

REPORT OF THE COMMITTEE ON DRAINAGE AND WATER SUPPLY.

To the Executive Committee of the Citizens' Association:

And by it Adopted and Ordered Printed, May 25, 1887. The Committee on Main Drainage and Water Supply respectfully submit the following report:

On January 27, 1886, the City Council of Chicago passed the

following resolutions:

Whereas. Pure water and scientific drainage are necessities of this community, and the people demand a system of water supply and drainage adequate to meet the requirements, not only of the present, but of years to come, nor will any temporary expedient or makeshift satisfy them; and,

WHEREAS, A thorough and permanent system of supplying pure water to our citizens and caring for the drainage of the municipality, cannot be paid for out of current taxation, therefore it is desired that a plan shall be devised and perfected before the next meeting of the legislature, to the end that nec-

essary legislation may be had.

"For the purpose of carrying into effect the objects sought, there is recommended, the appointment by the Mayor of a commission to consist of one expert engineer, whose reputation is so high that his opinion and report will command the respect of the community, and with him one or two consulting engineers, of like experience in engineering and sanitary matters. The duty of this drainage and water-supply commission, made up as above set

forth, should be to consider all plans relating to drainage and water supply which may be brought to its attention: to make such examinations and investigations and surveys as may be deemed necessary; to collect all information bearing on this problem; to consider all recent developments in the matter of sewage disposal, and their application to our present and future needs; to consider and meet the necessity of increasing our water-supply and of protecting the same from contamination; to remedy our present inadequate methods of drainage and sewage disposal, to consider the relations of any system proposed to adjacent districts, and whether there may not be a union between the city and its suburbs to solve the great problem, to determine the great question, as to the interest which the state and the United States may have in the disposal of sewage by way of the Illinois River, and to devise plans to meet any objections thereto, if such a system shall be thought best; and in general to consider and report upon any and all things which relate to the matter of water-supply and drainage of the city of Chicago.

The Commission should report on the whole matter committed to it in the most full and comprehensive manner, with maps, plans, and diagrams complete, and accompany the report with estimates of the first cost and annual requirements for the maintenance of the system

proposed.

The Report of the Commission should be made as early as practicable, and not later than the convening of the next session of the Illinois legislature in January, 1887."

The Commission on Drainage and Water Supply appointed under this resolution, consisting of Rudolph Hering, as Chief Engineer, and Benezette Williams and S. G. Artingstall as consulting engineers, in their preliminary report of January, 1887, recommended the adoption of sewage disposal which would turn a large stream of water from Lake Michigan through the Chicago River, and thence down the Des Plaines River into the Illinois River, carrying along with it in a highly diluted state, the sewage of the city as well as that of the towns along these rivers.

Two other possible methods were considered, viz.: Discharge of the sewage into Lake Michigan and taking the water at some point north, say Grosse's point; and "Land Disposal," which means collecting the sewage into great main sewers and

pumping it out upon land, to be procured for the purpose. The Des Plaines system is preferred for a number of reasons: 1st. It will be the least expensive by many millions of dollars. 2d. It is the most comprehensive and satisfactory. 3d. A channel of the requisite capacity to carry off the storm water from the area provided for, at the same time that it carried a large and steady stream of pure lake water through the heart of the city, taking up and completely diluting the sewage, will, to use the language of the commissioners, "from the necessary dimensions and its regular discharge, produce a magnificent waterway between Chicago and the Mississippi River, suitable for the navigation of boats having as much as 2,000 tons burden," and "establish an available water power between Lockport and Marseilles fully twice as large as that of the Mississippi River at Minneapolis."

This "Des Plaines System" involves the construction of the

following works:

A channel from the South Fork of the Chicago River along the Ogden Ditch to the Des Plaines River at Summit. and thence along the bed of that river to Joliet. pacity of this channel, as appears by the preliminary report of the commission, is to be 600,000 cubic feet of water per minute, or say, 200 feet wide by 18 feet deep, or 160 feet wide by 22 feet deep, with a current of 2 miles an hour. This capacity is required, according to the testimony of the en-

gineers.

"to keep the sewage from backing out into the lake in times of flood, to contaminate our water supply when the city is virtually taking a bath. After the diversion of all possible tributary waters to Lake Michigan, there will remain 125 square miles of the future drainage district, partly paved and sewered, and 295 miles of country district below Summit, tributary to the new channel above the first weir at Lockport. In this (channel) the lake water will be entirely replaced at times by storm water."

The cost of this work for the wider channel is estimated by the commissioners at between \$17,000,000 and \$20,000,000; the narrower channel can be built for about \$15,000,000.

A cut off from the Des Plaines commencing in the northeast corner of Leyden and running thence easterly to the North Branch, thence down the North Branch to Bowmanville, thence east to Lake Michigan. The object of this cut off is to divert from the Des Plaines and the North Branch the storm waters of about 500 square miles of territory lying north of the cut-off. This amount of flood water is in excess of the capacity of the proposed Des Plaines Channel and the cut-off is necessary, as before shown, to prevent these streams from forcing the sewage into the lake in times of flood. It will also be of great advantage, if not of necessity, in keeping the water of the Des Plaines out of the main channel during the progress of its construction below Summit. The cut below that point is through rock and the excavation cannot be carried on under water. This cut-off, with a dam at Summit, is estimated to cost between \$2,500,000 and \$3,000,000.

3d. Pumping works and locks in the North Branch in connection with the cut-off for the purpose of cleansing that

branch south of the cut-off, to cost about \$150,000.

4th. A separate system of sewers to collect the sewage now discharged directly into the lake and to carry it into the river, at a cost of about \$600,000.

5th. A channel from Lake Calumet to the Sag at cost of be-

tween \$2,500,000 and \$3,000,000.

6th. A diversion of the flood water of the Calumet River at

a cost of between \$350,000 and \$400,000.

The commissioners find that in designing any permanent plan of drainage and water supply for Chicago, a certain area embracing the city and several suburbs must be taken into

account and treated together. They say:

"Investigation has shown that topographical conditions clearly define two districts for the future metropolis. The main district extends from the line of 87th street on the south to the north line of Evanston and from the lake westward to the Des Plaines River. The other extends over the natural drainage area of Calumet Lake and River south of 87th street."

This area is occupied by several distinct municipalities, viz.: The city of Chicago, the towns of Hyde Park, Lake, Calumet, Worth, Cicero, Lyons, Riverside, Norwood Park, Jefferson, Lake View, Evanston, and Niles, and in some of these, incorporated villages. Neither of these has the requisite power to proceed with such a system alone, nor is it practicable, if indeed it is possible for them to act conjointly. There is therefore no way left but for all the outside towns to become annexed to the City of Chicago, or for Chicago and these towns to unite in creating a new municipality co-extensive in its limits and jurisdiction with the area and subject matter to be treated. If all the outlying towns mentioned were at the present time a part of the city of Chicago, several serious

practical difficulties would stand in the way of the execution of the system recommended. Chicago is incorporated under the general city and village act, which does not give power to construct the works necessary to be constructed outside its corporate limits, such as the Des Plaines Channel, the Bowmanville cut-off and Sag Channel. This might possibly be remedied by an amendment to that act; but a more serious difficulty would exist in the fact, that the debt of the city of Chicago is now about \$2,000,000 in excess of the constitutional (5 per cent.) limitation upon the entire valuation of the property in the proposed municipality. The limitation upon the amount of annual tax a city may levy is still another difficulty that would stand in the way of the execution of so great a work.

The Committee, in the preparation of a bill to carry out the recommendation of the commission, were therefore driven to the necessity of providing for the organization of a new municipality, co-extensive in its territorial limits and jurisdiction with the area involved in the system proposed and with powers equal to the requirements. We refer to the bill now on third reading in the House of Representatives, and known as the Hurd Bill, and which was endorsed, and the passage of which has been urged by the executive committee of the Citizens' Association. Its terms are known by your body, but it

may be well to give an epitome of it:

It authorizes the organization of a metropolitan town to contain not less than 500,000 inhabitants and comprising not less than five townships. It must be adopted by a vote of each of the towns that shall form a part of it. The corporate powers are to be exercised by a board of four commissioners to be appointed by the governor. Their term of office is four years. No more than two of the commission are to be taken The officers of the corporafrom the same political party. tion are to be a clerk, a treasurer, a chief engineer, and an attorney, to be appointed by the commissioners. Careful provisions are made as to the mode of keeping the funds, keeping, auditing and paying accounts and warrants. The powers of the municipality are expressed in general terms and are sufficient to allow of the adoption of any plan of sewerage and water supply that may be thought best; but the Des Plaines System was kept especially in view and all the powers requisite to go beyond the corporate limits to acquire property and construct any and all necessary works, are contained in the bill. The corporation is authorized to borrow money for the corporate purposes, not exceeding five per cent. of the valuation of the property within the corporate limits; but no greater amount can be borrowed in any one year than is needed for that year, and the bonds to be issued for the same are to be made to fall due at such times that the money which the constitution requires shall be provided for the payment of the loan can be applied as it is raised, instead of creating a sinking fund which generally lies idle while the bonds continue to draw interest.

The corporation is given power to levy taxes not exceeding in any one year one dollar on each \$100 valuation. It is also given power to make special assessments and condemn prop-

erty under Article IX of the City and Village Act.

The object of the corporation is the adoption, construction and maintenance of a system of main drains and sewers and of main water tunnels for the supply of water to the several municipalities embraced within the metropolis. These municipalities are each to take the water from the tunnels by their own pumps at a price (wholesale) to be agreed upon, and to distribute it to their people in their own way and at their own rates.

A joint committee of the Senate and House of Representatives was appointed to investigate and report to the two houses the effect the proposed plan of sewerage would have upon the Des Plaines and Illinois Rivers, and much time has been spent in presenting testimony before that committee upon that subject and finally a report was made by the committee to the several houses recommending the passage of the bill

with certain amendments.

The most important of these amendments provides that if a channel is constructed along the Des Plaines River it shall be of a capacity of not less than 600,000 cubic feet of water per minute, and shall not be less than 160 feet wide on the bottom and not less than 18 feet deep. This capacity is the same that is recommended in the report of the Commission as necessary to carry off the storm water and prevent it from backing the sewage into the lake in flood times.

It has been said that the bill has been so amended as to require expensive iron bridges to be built by the corporation upon the demand of the towns along the channel, but this is not true. The only requirements on this subject is that bridges over the navigable part of the channel shall be so constructed so as to allow of the passage of vessels. Neither is it true, as has been said, that the bill gives away the water

power to be created at Joliet. The channel, according to the plans of the engineers, is to be built to a point in Joliet where the water power will be greatest. The law is well settled that when water escapes from an artificial channel into a public river, all right of property or control over it is gone from the proprietors of the channel. See Adams v. Slater,

8 Brad., 72.

An amendment was, however, put upon the bill in the House, upon the motion of Mr. Browne, of LaSalle County, which requires the purchase of a sewage farm and the treatment of the sewage with certain named chemicals. No doubt some voted for this amendment under the mistaken impression that it is practicable to extract from the sewage a valuable fertilizer to be introduced into commerce. It has been determined in those parts of the country where fertilizers have the highest merchantable value, as in Boston and Providence, that, in the present state of the arts, fertilizing material cannot be economically extracted from sewage. (See Boston City documents, 1887, No. 70, page 18.)

There are some reasons that seem to the Committee to be of great weight in favor of the passage of the bill, even with this objectionable amendment. If the bill were to become a law, we may reasonably expect, from subsequent legislation, such a modification of this amendment as would free the matter from serious embarrassment. In fact, such a modification was at one time agreed upon. You call our especial attention to the Roche-Winston Bill now pending in the Senate, and re-

quest a statement of its scope and probable utility.

The bill makes the city of Chicago a Drainage District and gives the corporate authorities of the city the powers expressed in the act of June 22, 1885. It expressly gives the city authority to construct the Bowmanville Cut-off for the diversion of the flood waters of the Upper Des Plaines and North Branch and to build a dam or levee along the east bank of the Des Plaines at Summit, to prevent that river from running over into Mud Lake and thence into the Chicago River in flood times. The bill gives the usual powers to enable the city to acquire right of way, etc. The cost of constructing and maintaining this work is "to be defrayed by special assessment upon the property benefited thereby, within such district (the city of Chicago) alone."

If a Metropolitan municipality shall be hereafter created and permission given it to dispose of the sewage by way of the Des Plaines River and through such a channel as we have described, this cut-off will answer all the purposes of its construction. So long as we use the canal for sewage disposal. as now, this cut-off will be useful in controlling the flood waters of the Des Plaines and North Branch, and reducing the violent flushings which occasionally scour the Chicago River, carrying the sludge and filth into the lake.

The Roche-Winston Bill was not intended to antagonize or take the place of the Metropolitan plan of organization as contained in the Hurd Bill. On the contrary the Bowmanville cut-off is a part of the "Des Plaines System," and its construction is only consistent with the adoption and carrying

out of that plan under such an organization.

The question is raised whether that work is the proper subject of a special assessment upon the land of the City of Chicago, or in other words, whether the expense of it is not in the nature of a general burden to be borne by general tax-This is a question of law upon which the committee expressed no opinion. The bill provides that the work shall be done by special assessment, as that is the only way it can be done without submitting the act to a vote of the people which would cause the delay it was the purpose of the bill to avoid. It is desirable then, that both bills should become law at once and the people given their choice under which the work shall be done.

Under the Hurd Bill no more money can be raised by taxation or by borrowing, in any one year, than is required to be expended in that year. It is estimated that it will require from seven to ten years to complete the work, and that the amount to be raised and expended will not exceed \$2,500,000

in any one year.

Your committee believe that nothing less than the adoption and completion of the whole system will remedy the great evils from which we are suffering, and that the city and its suburbs can well afford the cost involved for the relief which

it will bring.

DANIEL L. SHOREY, MURRAY NELSON, H. B. HURD. MARTIN A. RYERSON, BRYAN LATHROP. Committee on Main Drainage and

Water Supply.

REPORT OF GEORGE Y. WISNER, ASSISTANT U. S. ENGINEER, CHICAGO, JANUARY 22, 1883. CHIEF OF ENGINEERS REPORTS 1883. Page 1773.

Survey and Estimates for Enlargement of the Illinois and Michigan Canal.

Report of Mr. George Y. Wisner, Assistant Engineer.

United States Engineer Office,

Chicago, Ill., January 22, 1883.

Major: I have the honor to submit the following report of survey and estimates for enlargement of the Illinois and Michigan Canal, from Chicago to the Illinois River at La-Salle.

In compliance with your instructions of October 3, 1882, I have made a careful survey of the Canal, and determined cross-sections at intervals of 500 feet throughout its entire

length.

These cross-sections have been platted, and may be utilized for computing cost of enlargement in case any other size of prism of canal should finally be adopted than that now proposed.

The canal property consists of a strip of land 240 feet in width (90 feet each side of canal) with a few exceptions through villages and across the sixteenth sections of town-

ships.

For about 15 miles from Chicago the cutting for canal is principally through clay, and for a larger portion of the next 20 miles the canal is cut through limestone rock. The remainder of the route is through clay and sand loam, with

occasional beds of rock and gravel.

A large amount of material needed for construction may be obtained on the canal property, which, with the extensive quarries adjacent to the canal near Lockport, renders the cost of enlargement very reasonable. The present canal is a little over 60 feet wide at surface and of irregular section, averaging about 390 square feet sectional area.

The locks are 110 feet long, 18 feet wide, and 6 feet deep

on miter sills.

The following estimates have been made for prism of canal similar in size to that proposed for the Hennepin Canal, viz: 80 feet wide at surface, 59 feet wide at bottom, and 7 feet deep,

with locks 170 feet long, 30 feet wide, and 7 feet deep on miter sills. The sectional area will be 485 square feet, or about 25

per cent. larger than that of present canal.

The new pumping works now being erected at Bridgeport are expected when completed to deliver in canal about 1,000 cubic feet of water per second, which will make a mean velocity of current in the present section of canal of about 1.7 miles per hour, and for the proposed section 1.4 miles per hour. With a loaded boat occupying a large portion of this cross section, the current will be much too heavy for economy of transportation, and if the canal is to be used as an outlet for Chicago sewage, I think the prism should be made much larger than that now proposed.

The water supply for the present canal will be ample. No survey was made of the feeders but from information obtained I think they are in about the same state of repair as the

present canal.

It is expected to obtain the increase of depth in canal, from Chicago to the DuPage River by dredging, but from the DuPage River to LaSalle it will be much more economical to raise the height of water in the levels one foot, thus saving a large amount of excavation. The excavation being in excess of the amount of embankment required, no extra expense will be

incurred by raising the banks.

No changes have been made in the location of locks. The estimates for material in locks have been made for cut stone for face of walls and culverts, and uncut stone for remainder of masonry. Feed culverts are to be built through the lock walls, for regulating the flow of water in canal, and the foundations to be of concrete, except where lock walls are built directly on the native rock. The aqueducts on the line at present have wooden trunks about 24 feet in clear width, supported on stone abutments and piers.

Estimates have been made for repair of masonry and for new trunks to correspond in size with the proposed enlarge-

ment.

All bridges less than 15 feet in the clear above water in the canal should be raised. The abutments for several of the bridges will have to be rebuilt.

The stone arch culverts under the present canal will need no alterations, but there are 12 wooden box culverts which

should be replaced by stone ones.

Through sand, loam, and gravelly soils, slope walls will be

required to protect the banks from caving. The canal should

also be fenced for a greater part of its length.

Estimates have been made for waste weirs with gates at Lockport and at Marseilles, which, with surface weirs on the longer levels for escape of water from heavy rains, will be sufficient for regulating the height of water in canal. The dams in Des Plaines River at Joliet, and in the DuPage River, will need no repairs at present.

The accompanying profile shows the elevation of ground with reference to water surface of present canal. The curves showing the amount to be excavated are platted from ordinates representing the number of square yards in the respective sections. The mean ordinate for any section multiplied by the length of section in yards will equal the number of cubic yards

of excavation required.

There are 17 locks and watchmen's houses belonging to the canal property, nine of which have been built within the past

five years, and the others have been recently repaired.

I am under obligations to Mr. Wm. Thomas, superintendent of Illinois and Michigan Canal, for valuable information furnished from the Canal office and also to Mr. John Ericson for able assistance in both field and office work.

Very respectfully submitted,

GEORGE Y. WISNER,
Assistant Engineer.

Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. A.

REPORT OF CAPTAIN W. L. MARSHALL, U. S. ENGINEER AT CHI-OAGO, ON A SURVEY OF A WATERWAY FROM LAKE MICHIGAN TO THE ILLINOIS RIVER AT LASALLE, APPENDIX JJ REPORT OF CHIEF OF ENGINEERS FOR 1890. PAGE 2419.

Survey of Waterway from Lake Michigan to the Illinois River at LaSalle, Illinois.

United States Engineer Office. Chicago, Ill., February 28, 1890.

General: I have the honor to submit the following report upon a survey of a waterway from Lake Michigan to the Illinois River at LaSalle, Ill., forming part of a through route of transportation from Lake Michigan to the Mississippi River, required by Act of Congress of August 11, 1888.

The Act in question is entitled "An Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," and the items directing the survey, plans and esti-

mates, and relating thereto, are as follows:

"Improving Illinois River, Illinois: Continuing improvement Two Hundred Thousand Dollars. And for the purpose of securing a continuous navigable waterway between Lake Michigan and the Mississippi River, having capacity and facilities adequate for the passage of the largest Mississippi River steamboats, and of naval vessels suitable for defense in time of war, the Secretary of War is authorized and directed to cause to be made the proper surveys, plans, and estimates for a channel improvement and locks and dams in the beds of the Illinois and Des Plaines Rivers from LaSalle to Lockport. so as to provide a navigable waterway, not less than one hundred and sixty feet wide, and not less than fourteen feet deep, and to have surveyed and located a channel from Lockport to Lake Michigan, at or near the City of Chicago, such channel to be suitable for the purposes aforesaid; the necessary expenses of such surveys, estimates, plans and location to be paid for out of the sum herein appropriated for the improvement of the Illinois River."

In compliance with the orders of the Chief of Engineers a project for this survey was submitted September 21, 1888, which was approved September 25, 1888. The expenses of the survey to be paid from an allotment of \$25,000 from the appropriation for the improvement of the Illinois River.

A letter of instructions was received from the chief of engineers, dated August 27, 1888, a copy of which is herewith, directing that whatever line might be found most advantageous and economical to the United States, and best suited to subserve the ends in view, that plans and estimates in any event should be submitted for a route terminating within the (then) limits of the City of Chicago sufficiently distinct and in detail to enable the Chief of Engineers to form a definite and conclusive opinion as to its merits regarded from the standpoint of the commercial and sanitary interests of Chicago.

In accordance with the approved project, and with the instructions received, a survey party was organized and put into the field October 1, 1888, under directions of Assistant

Engineer L. L. Wheeler, a gentleman of many years' experience of that character in the Government service, and by the close of the season, December 1, 1888, the field work relating to the superficial survey of the various practicable routes from Lake Michigan, at or near Chicago, via the Chicago Divide and the Des Plaines River Valley, as far as Joliet, Ill., were practically completed. From Joliet to LaSalle a survey was made under direction of Maj. W. H. H. Benyaurd, Corps of Engineers, U. S. Army, by Assistant Engineer George Y. Wisner, in 1883, and to avoid unnecessary duplication of work and expense this survey was adopted, as far as it was found sufficient for the purpose, for the basis of the estimates herewith, for that part of the route covered by it.

The most practicable routes across the Chicago Divide, and which have been long known and recognized, are two, each of which admits choice of location, the valleys being quite

wide.

(1) By way of the Chicago River and its South Branch and the present location of the Illinois and Michigan Canal, or Mud Lake and the Ogden Ditch, to the Des Plaines, near Summit, about 12 miles from the City Hall of Chicago and about 8 miles from Bridgeport; thence via the Des Plaines River Valley, uniting at Sag Bridge with route.

The 14-Foot Channel.

Page 2425. The Act of Congress in question, requiring plans and estimates for a channel at least 14 feet deep and at least 160 feet in width, has been complied with, and estimates on this basis are also submitted. This channel will accommodate, of course, with greater facility all large vessels that can reach its terminus at LaSalle through the channel of the Mississippi River, at present about 41 feet in depth at low water, to be increased, if practicable, to 8 feet at low water below St. Louis, and to 6 feet on the Upper Mississippi; and through the lower Illinois River, at present from 16 to 18 inches in depth on the unimproved section, to be ultimately 7 feet deep at extreme low water, with locks 350 feet in length and 75 feet in width of lock-chamber. Vessels now existing on the Mississippi River that cannot be accommodated by the 8 feet deep channel at extreme low water will not be accommodated by the 14 foot channel 160 feet wide, but every increase in depth up to a certain limit of a navigable waterway increases the facility with which it can be navigated by large vessels;

a channel from 14 feet in depth at extreme low water in Lake Michigan to 18 feet at high water across the Chicago Divide can be navigated by similar large boats if still water, or with a very moderate current, with greater facility and ease than a still-water channel from 8 to 12 feet in depth. This is the best argument for such a channel, based upon the present or probable future navigation of the Mississippi River and tributaries; it is not a public necessity.

As for the practicability of such a channel under the condition imposed by the Act that it shall occupy the bed of the Illinois and Des Plaines Rivers more will be said hereafter

in this report.

Artificial waterways connecting superior navigations even are generally restricted and obstructive, and limited by motives of economy to the least dimensions that will accommodate the vessels that will probably seek their use. For this reason, probably, no channel has been recommended by any engineer under governmental or State authority exceeding 8

feet in depth across the Chicago Divide.

The supposed necessity for a minimum channel 14 feet in depth from Lake Michigan to the Mississippi River, at the mouth of the Illinois River, is given by the chief engineer of the Chicago Sanitary District, lately organized under the Act of the Illinois Legislature, approved May 29, 1889, entitled "An Act to create sanitary districts and to remove obstructions in the Des Plaines and Illinois Rivers," in an article published in the Chicago Tribune, dated January 29, 1890. It is given here because the author represents the only interest demanding such a channel and presumably offers the most cogent arguments available for governmental action.

Page 2428.

No greater depth of channel than 9 feet at extreme low water in Lake Michigan across the Chicago Divide seems necessary for navigation by vessels similar to the largest Mississippi River craft, that can neither use it nor reach it; but a channel of much greater capacity, discharging a large volume of water into the Illinois and Des Plaines Rivers not necessary for navigation in a canalized river, as this must necessarily be, is made locally urgent by the sanitary necessities of the City of Chicago for drainage and an uncontaminated water supply, as shown in the Appendix to this report. These necessities end when the Chicago Divide is passed and the discharge turned into the channels of the river. Beyond the Chicago Divide, then, there is no apparent necessity at present, nor likely to exist in the near future, either national or local, for any channel of materially greater capacity than the minimum herein estimated for between the Mississippi River and the Great Lakes, but every increase in depth and width of channel up to a certain limit throughout the artificial channels will increase the facilities for navigation without probably affecting the character, size or draught of the boats that will use it as a through route of transportation, i. e., Western river steamboats, barges, and towboats.

Location and Estimates.

The accompanying report of Assistant L. L. Wheeler, gives such a full description of the various routes surveyed that it is unnecessary to again repeat it herein, and reference is made to his report and the maps and profiles herewith submitted for such details. In locating the proposed routes and structures required, and in determining the bases of the estimates, much study was devoted by Mr. Wheeler and myself in this office, and his reported locations and estimates have been made after the various points involved were thus determined, and under the instructions of the Department.

The two routes estimated for, i. e. via Chicago River and via the Calumet River and the "Sag," unite at the Sag Bridge, about 17 miles from Blue Island and Bridgeport, and thence

to LaSalle, coincide.

Chicago River Route.

The route proposed follows the Chicago River from its mouth via its South Branch to near Bridgeport, thence via the West Fork of the South Branch and the Ogden Ditch to Summit, thence paralleled to the present location of the Illinois and Michigan Canal, on lower ground, three miles more or less, where it enters the bed of the Des Plaines River, which it practically follows, cutting off bends to Sag Bridge, where it unites with the second or Sag route.

The route is preferred to the present location of the Illi-

nois and Michigan Canal, or one adjacent to it.

(1) Because it occupies lower ground, and the probable amount of excavation required is less, since the earth excavated from the old canal still remains as spoil banks to be removed.

(2) Because the old canal is paralleled by a railroad on each side, and there is not sufficient room for the enlargement

of the canal without condemning the railroad right of way

and removing one or both of the tracks.

(3) Because the present canal is the property of the State of Illinois, and the conditions of transfer have not been accepted by the United States. These conditions are such that their acceptance would involve greater cost than a new right of way.

(4) The Illinois and Michigan Canal is the main sewer of the City of Chicago, as well as a commercial highway, and cannot well be enlarged without either interfering seriously with its uses or at increased cost of work from delays due

traffic upon the canal.

(5) As a means of transportation and drainage it is of advantage in the prosecution of the work parallel to it to maintain it in a serviceable condition during the construction

of the larger canal.

(6) For several miles of its course between Willow Springs and Lemont it is excavated in solid rock that the new route avoids, so that the old canal location could not be followed in any event with advantage further than throughout the earth section.

Page 2436.

Attached to this report will be found the full preliminary report of the special commission or board of experts employed by the City of Chicago to examine into the question of drainage and water supply, made in 1887; also the laws and joint resolutions of the Legislature of the State of Illinois relating to the same matter, and authorizing the establishment of "Sanitary Districts, etc.," which will give a clear explanation of the requirements of the case and the proposed remedies.

Without going into the subject in detail, which is better treated in the report mentioned than it could be by me, it is sufficient to state that after examination by capable experts the conclusion has been arrived at that it is necessary, for sanitary reasons, to construct a channel or channels from the lake to the Des Plaines valley, beyond the Chicago Divide, capable of carrying to the Illinois River from 300,000 to 600,000 cubic feet of water per minute, to carry off and dilute to inoffensiveness the sewage of this great city, to prevent contamination of its water-supply necessarily taken from Lake Michigan; and that the necessary legislation to enable the

city to undertake the work has been obtained from the State

Legislature.

Many propositions have been bruited, involving various schemes for the diversion of the flood waters of the Des Plaines; channels of large capacity in addition to, and to supplement, the natural drainage lines of the Chicago River and the main Drainage Canal, etc., but up to this date no per-

fected plan has been formulated or adopted.

Whatever may be the ultimate fate of the various proposed cut-offs and diversions and auxiliary channels, it may safely be reasoned that economy will govern, and that the essential objects of the city of Chicago will be first obtained by the most direct and inexpensive use, to their full capacity, of the natural drains, with such sewers, conduits, and pumping works as will secure proper outfalls into these drains, and satisfactory transfers of the contents of otherwise dead branches to the main Drainage Channel, i. e., by the utilization to the full extent allowed by the law of the Chicago River and its branches.

From this may be inferred a current of not exceeding three

miles an hour in the Chicago River and its south branch.

Any marked current in such an obstructed stream means danger to the heavy and unwieldly vessels that frequent it, especially if built of metal; and a current of even less than three miles an hour obstructed by numerous stone piers, a multitude of vessels, and many sharp bends will have its effect upon rates of insurance and upon the minds of vessel

owners and owners of dock property.

In its present condition Chicago River cannot be navigated at all by large Mississippi River steamboats. Nearly all the bridges, which are the property of the city of Chicago, must be reconstructed if this route be adopted and a material increase in the already too great number of vessels using the river result. No large Mississippi-River steamboat can turn in the river, but must run the gauntle of all its bridges and piers, after reconstruction, to Lake Michigan for that purpose, or else a commodious turning-basin be constructed for such purposes.

In the practical execution of a channel via this route the Des Plaines waters must be contended with and may materially increase the cost of the route, but as there has been expressed by contractors of experience a doubt upon this point, based upon the ground that the facilities for dredging from Bridgeport to Summit are better and that the material

can be sold to brick-makers and for filling to reduce the ultimate cost, the estimates over the two routes are made on the

same basis of cost per unit.

Generally speaking, then, it may be stated that the Chicago River is a very unfavorable terminus for this highway as far as the interests of navigation are concerned, also as far as future demands and facilities for increased commerce by water are concerned, but that for sanitary purposes a channel along substantially this line has been decided to be a vital necessity for the city of Chicago.

Page 2444.

2. Effects of Definite Increased Discharge on Channel Depths.

It will be seen from the appendices to this report that a discharge of from 300,000 to 600,000 cubic feet per minute from Lake Michigan into the Illinois River is contemplated for sanitary purposes by the city of Chicago, and that the United States Government is requested by the Illinois Legislature to abandon its adopted system of improvement by slackwater on the lower Illinois River and attain the same object by means of this increased discharge. The effects of such discharge upon this section of the river, as well as upon the part of the route from LaSalle to Lake Michigan, is, then, a proper subject of discussion herein. Page 2449.

Chicago Drainage and Waterway Laws.

Up to the present time the improvement of the Illinois River has proceeded upon the strict national basis of the requirements of navigation, and as late as 1887, no reason for any increase in the dimensions of the channel proposed for this improvement and in course of execution on the lower Illinois had been developed. The Illinois legislature at its session in 1887 passed an act of cession, ceding to the United States the State works occupying part of the line, upon the condition that the United States should carry the improvement through from the Mississippi River to Lake Michigan on a basis of 7 feet depth of navigation, but in 1887, also, the commission of experts employed by the City of Chicago to examine into and report upon the best plan for drainage and water supply submitted its preliminary report, which contains the first official demand from any source for a navigable channel of great discharging capacity several times the depth neces-

sary for navigation across the Chicago Divide, and is the origin and basis of the present requests of the legislature of Illinois for the construction by the United States government of a waterway 160 feet wide and 22 feet deep across the Chicago Divide as far as to Lake Joliet, and for a channel 14 feet deep thence to LaSalle, the former act of cession of the State works at the same cession being repealed.

We now find this proposed route, instead of being urged upon a purely national basis, encumbered with conditions that have no relation whatever to any national ends or objects, but purely dependent upon local necessities for sewerage and water-supply as the real governing basis, while a great waterway is urged as a national necessity to secure United States

aid.

With reference to the "Chicago Drainage and waterway laws," a few remarks may be found in the Annual Report of the Chief of Engineers for 1889, page 2130, et seq., to which These remarks are supplemented reference is here made.

and made more clear by this report.

No channel as deep as 22 feet has yet been constructed upon the Great Lakes, nor have any of the harbors on the Great Lakes been constructed of that depth. The entrance to the harbor of Chicago, which exceeds any port of the United States in number of arrivals and departures of vessels, is only 16 feet in depth below low-water in Lake Michigan. At the Mississippi terminus of the line there exists less than 6

feet at low water.

Granting the necessity for a channel-way of large capacity across the Chicago Divide, a narrow and deep channel with a more or less rapid current is not of the character demanded by western river navigation. The heavy business of these rivers, especially of the Mississippi and Ohio, is transacted by barges and towboats, or by wide flat-bottomed steam boats of comparatively light draught. If any channel, therefore, of materially greater capacity than the minimum herein estimated for be constructed by the United States government across the Chicago Divide, it would be infinitely better for purposes of commerce and navigation that it should be doubled or trebled in width, with the locks suitably increased in span and length to accommodate powerful tow-boats with their full tows than that it should be restricted in width and made so deep, with a more or less obstructive current therein.

No one cognizant of the necessities of the city of Chicago for better drainage and a purer water supply can fail to sympathize with her efforts to arrive at a solution of the problem, and as both the channel for drainage and the channel for navigation across the Chicago Divide must necessarily occupy the same field, it is manifestly the duty of the General-Government, to prevent unnecessary expenditure, in planning its work to so construct them that while subserving strictly the necessities of the public generally, that they shall conduce also, as much as possible, to the health, comfort, and general welfare of the special locality. It is not so clear, however, that these works should be constructed of greater capacity, or at materially greater expense to the National Treasury, than demanded by national interests for the purpose of meeting purely local necessities, when these necessities have not arisen from any act of the general government.

If, then, the capacity of the channel required by national interests should be first definitely decided upon, and the work be constructed by the General Government in accordance with this decision, across the rock up-lift at Lemont, and the City of Chicago be then allowed to avail herself, under proper conditions, of this work by enlarging and deepening such parts of it as are necessary for her purposes, it would detract but little from its value as a navigable channel due to the introduction of a current into an otherwise slack-water canal, over such a short portion of the route, while saving at the same time probably 50 to 60 per cent of the cost of this most expensive part of her drainage canal to the city of Chicago.

Such a solution would seem just and proper, provided that, if the United States should be held responsible for flowage damages along the Illinois River due the water thus artificially introduced into the rivers through its channel, they should control the discharge of the canal thus constructed for such periods as it might cause overflows and damage, and possibly great obstruction to navigation in the river below that would not occur without this addition.

As shown in this report, the overflow stage is reached near LaSalle at about 7.5 to 8 feet above present low water, at a discharge of 18,000 cubic feet per second; at LaGrange at a discharge of about 30,000 cubic feet per second; at Kampsville, at a discharge of about 40,000 cubic feet per second, but when the Mississippi is high, at a much less discharge. Upon the upper Illinois there is no data to determine at what stage

and discharge an introduction of an artificial discharge would cause damage.

This artificial discharge is not necessary for navigation

anywhere along the line, and cannot be said to benefit navigation anywhere to such an extent as to justify the United States government assuming responsibility for flowage damage caused by it.

The discharge is proposed to be constant, whereas if it were produced by the United States for the benefit of navigation it would be introduced into the Illinois only at low stages, when it would be beneficial to navigation and harmless to

property.

Now, at any little summer freshet, producing a discharge exceeding 8,000 cubic feet per second at LaSalle, damage by overflow would begin at that point, the artificial discharge being 10,000 cubic feet per second, and with greater natural discharge become more and more wide-spread as we progress down-stream, at times when such overflows would not otherwise occur. Upon all rises of the river producing anywhere near bank-full stages this artificial discharge would cause flowage damages that would not otherwise occur. The lands would become submerged at high water earlier, and the water remain upon them longer than it otherwise would. From 100,000 to 300,000 acres of land in the Illinois River valley will be subject to such conditions.

Page 2451.

That feature, therefore, in the Chicago drainage and waterway laws that requires a constant discharge of from 300,000 to 600,000 cubic feet per minute seems, in view of past experience, decidedly objectionable if the water is to be introduced through any canal either owned or used by the United States for public purposes if by such ownership or use the United States can be made responsible for damages due to

such constant discharge.

There is nothing perfect under the sun, and the city of Chicago could find a reasonably satisfactory solution and a cheaper one, although not by any means a perfect one, of its sewage question by looking somewhat to the natural watershed of the Illinois to furnish some of the water required by the law for the dilution to inoffensiveness of its sewage by sending into the Illinois River a variable quantity of Lake Michigan water, depending on the state of that stream, all required by the law when it can be safely done, less than this when it cannot, and upon exceptional floods, the inconveniences of which all should share, suffer with the Illinois Valley some of the discomforts dependent upon such conditions.

Such would be the modifications that control over the artificial discharge into the Illinois River would produce.

These are matters of detail that can be remedied by subse-

quent legislation.

By properly guarding and limiting the liability of the United States for flowage damages due water not necessary for navigation, but introduced either through United States channels or over United States dams, doubtless a satisfactory arrangement may be made by which this great city could profit by the necessary United States works, while the United States would not be put to unnecessary expense.

As the State law stands, however, demanding a constant discharge and unnecessarily great and expensive channels not demanded or suitable for the commerce to be subserved, a compliance with its terms does not seem advisable for the

United States.

In view of these facts and laws a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, i. e., with accurately determined contours at every foot elevation of surface, and with the areas of lands subject to overflow well determined, should be made by authority of Congress before any artificial discharge whatever is turned into the Illinois River, to determine the effects of such artificial discharge and the areas of lands that may be subject under any conditions to flowage thereby. Such a survey would cost probably \$250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the Government of the United States or the City of Chicago.

Commercial Advantages.

This route has invited attention as a practicable locus for a waterway between the Great Lakes and Mississippi River for many years, and its advantages have been so often reported to Congress that anything herein said would be mere repetition. It is sufficient to say that the minimum channel herein estimated upon will open a channel of commerce with a maximum annual capacity of 30,000,000 tons (foot note: Or 7,500,000 tons easily attainable capacity in practice.—W. L. M.) between the Great Lakes, with its terminus at their greatest port, and a system of navigable rivers penetrating one-half of the states and territories of the Union, with a total navigable length equal to more than half the circumference of the globe.

In the meantime attention is invited to the following reports hitherto submitted to Congress:

General J. H. Wilson, 1867, House Ex. Doc. No. 16 40th Con-

gress, 1st session.

Colonel Macomb, Corps of Engineers, Report of the Chief

of Engineers, 1875, volume 2, page 525.

Major G. J. Lydecker, Reps. Chief of Engineers 1879, page 1572; 1880, page 1995.

Maj. W. H. Benyaurd, Report of the Chief of Engineers,

1884, page 1958.

Maj. Thomas H. Handbury, Report Chief of Engineers, 1887, page 2119.

Report of the Board of Engineers on Hennepin Canal, 1887, Report of the Chief of Engineers 1887, page 2125.

Respectfully submitted, W. L. MARSHALL,

Brig. Gen. THOMAS L. CASEY. Chief of Engineers, U. S. A.

Page 2453.

United States Engineer Office. Chicago, Ill., May 1, 1889.

Captain of Engineers.

General: The survey ordered by Congress in the River and Harbor Act of August 11, 1888, item Illinois River, for a water-way of large dimensions (14 feet depth, 160 feet width). across the Chicago Divide to Lockport, thence via the channel of the Des Plaines and Illinois Rivers to LaSalle, has now arrived at the point that allows the estimates of quantities of excavation, etc., and cost of the cut across the divide to be begun.

As the department is aware, local necessities, as determined after examination by a commission of experts employed by the City of Chicago, demand a large discharge from Lake Michigan into the Illinois River for sanitary reasons. Navigation interests not only do not demand increased discharge for the Illinois River, but also in so far as an increased discharge introduces into an otherwise slackwater system a current that increases the cost and the difficulties of navigation in some proportion to the square of its velocity, would be positively injured thereby to the extent of the obstruction.

A navigable channel, therefore, demands no slope to the costly cut through the Chicago Divide. Local sanitary necessities demand a slope of not less than four inches to the mile, and a cut consequently deeper by from about seven feet to about 11 feet in rock, throughout about 12 miles, more or less, of the canal at the divide, at a probably increased cost of about \$60,000 per mile per foot depth, and for about 15 miles, more or less, an increased depth of cut, in earth, varying from 3 to 7 feet in depth, at a probable increased expense of about \$15,000 per mile per foot increased depth. In this case, also, the works below must be designed to provide for passing, at increased cost, the increased discharge.

The data accumulated by the survey is sufficient for estimating a water-way with any practicable slope and discharge consistent with reasonably easy navigation, 14 feet in depth; but, probably, not sufficient to estimate a channel of the extreme slope and discharge capacity required by Chicago.

I have to respectfully ask instructions from the Department whether it is the desire of the department that the estimates demanded by Congress shall be rendered on the basis of the requirements of navigation for the best channel for navigation, or whether the local drainage problem shall also be considered, or separate estimates made under each condition?

It is my desire to comply with the intent of the act, even if it involves the duty of touching upon purely local questions of sanitary engineering, still a matter of local discussion and dispute, but I am uncertain whether the elimination by amendment from the act passed of all mention of the discharge or capacity for discharge of the proposed channel, which was originally a feature of the bill, was intended to intimate that only estimates and plans for the channel, 14 feet deep, best adapted for navigation are desired by Congress, i. e., that national interests only are to be presented officially by United States Officers, and the local necessities be presented to Congress, if at all, by the petitions of localities interested, or by their representatives in Congress, or whether the terms "not less than 14 feet in depth," taken in connection with the wellknown capacities for navigation of the Illinois and Mississippi Rivers, was intended as equivalent to a direction to regard not only the interests of navigation which require no such depth of channel as the minimum indicated, but also other interests that, though purely local, may require the execution of such a scheme, if approved by the people of the locality, i. e., whether it is not the intent of the act that the United States officers shall make estimates and plans for local engineering projects not yet put in form for execution, nor yet authorized

by State law, nor even accepted yet by local vote, making the interests of navigation not paramount but subsidiary thereto.

Very respectfully, your obedient servant,

W. L. MARSHALL, Captain of Engineers.

The Chief of Engineers, U. S. A. (Through the Division Engineer of the Northwest Division.)
(First indorsement.)

United States Engineer Office, Detroit, Mich., May 3rd, 1889.

Respectfully returned to Captain Marshall, with suggestion that he present his own views upon this question and submit a definite proposition for carrying them into effect.

O. M. Pob, Colonel of Engineers, Engineer Northwest Division.

REPORT OF CAPTAIN W. L. MARSHALL, U. S. ENGINEER AT CHI-CAGO. APPENDIX MM REPORT OF CHIEF OF ENGINEERS 1891. P. 2611.

MM 4.

Improvement of Illinois River, Illinois.

The ultimate object of this improvement is to furnish a through route of transportation by water from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for its navigation by the largest class of Mississippi River steamboats that can reach the mouth of the Illinois River.

The dimensions that have been adopted for the locks to meet this requirement are:

The project now under execution is for the improvement of the lower sections of this route extending from the mouth of Copperas Creek to the Mississippi River, a distance of 137 miles. Another section of the river, 88 miles in length, from the mouth of Copperas Creek to LaSalle, has been improved by the State of Illinois by the construction of two locks and dams, one at Copperas Creek and one at Henry, Illinois.

Over this latter section the state still collects tolls, the United States not yet having accepted the conditions imposed by the act of cession of the Illinois legislature, which condi-

tions are such as to deprive the works of all value while demanding a great expenditure by the United States Government for works to be substituted therefor.

With regard to this subject reference is made to the Annual Report of the Chief of Engineers for 1889, page 2121, et

sequitur.

Under the act of Congress of August 11, 1888, surveys and separate estimates have been made, based upon low-water depths of 8 and 14 feet, for carrying the improvement from LaSalle to Lake Michigan via the Illinois and Des Plaines Rivers, and a cut across the Chicago Divide, over which section there is a fall in water surfaces, Lake Michigan being the summit of about 141 feet.

The report upon this survey and estimates have been printed as House Executive Document No. 264, 51st Congress, first session, and is also published in the Annual Report of the Chief

of Engineers for 1890, page 2419 and following pages.

Other surveys and estimates have also been made by the trustees of the sanitary district of Chicago, organized under laws of the State of Illinois for cutting a capacious channel carrying a large discharge from Lake Michigan into the Illinois River for drainage and sanitary purposes. The reports and estimates of the engineers of this latter body are hereto

appended.

No prevision has yet been made by Congress for embarking upon the construction of the necessary works of navigation over the last-mentioned section, i. e., from LaSalle to Lake Michigan, but the State of Illinois has provided by law for the destruction of the navigation by locks and dams, over the section of the Illinois River from LaSalle to Copperas Creek, by requiring the removal of the locks and dams at Henry and Copperas Creek, in the event they are not accepted by the United States, under the conditions stated therein, within four years from July 1, 1889, whether any other system of navigation be substituted therefor or not by that time. The navigation of the Illinois River is now and will be necessarily dependent upon these works for years, and the utility of the Illinois and Mississippi Canal as a through route will depend upon the maintenance of the works at Henry until the same depth of water is otherwise obtained.

The present project involves the construction of two locks and dams, one at LaGrange, 79 miles above the mouth of the Illinois, the other at Kampsville, 31 miles above the mouth, and dredging the channels to 7 feet depth at extreme low water

over bars. More than 2,000,000 cubic yards of dredging is required.

Page 2613.

PROPOSED APPLICATION OF FUNDS ASKED FOR, FOR THE FISCAL YEAR ENDING JUNE 30, 1893.

It is proposed to apply the funds now on hand and those asked for herein to the completion of the Kampsville Lock and Dam; to renovating the dredging plant and to dredging the channels through bars and completing the existing project.

Whatever may be the result of municipal or local works, the execution of which may make possible an improvement of the lower Illinois by other methods than by locks and dams, it must be considered that even yet, nearly two years after the creation and establishment of an organization to carry on a work which was said to be sufficiently understood to justify the legislature of the State of Illinois to indicate to the United States the work required, on the basis of municipal necessity, and to direct the destruction of valuable works of navigation on the Illinois River, no definite plans have been worked out, formulated, and adopted. The channels proposed have been twice located and estimated, in part; but the details as yet are unknown, the rights of way unsecured, and the inauguration of the work still in the future.

Doubtless this municipal work will be executed as a sanitary necessity, but it will take many years for its inception and completion. Meanwhile the interests of navigation on the Illinois River should be provided for by the completion of the existing project now so near consummation, and the future course of the improvement be adjusted to the conditions that will be probably revealed in time. It would not now be wise to abandon a work that will certainly fulfill the requirements of navigation on the lower Illinois at very small expense because that possibly in the next generation these works may be incidentally rendered unnecessary by the execution of work

for another purpose and as yet not even begun.

Whenever the large channel contemplated by the City of Chicago for drainage is actually determined upon, in view of the fact that a channel for navigation and the channel for drainage across the Chicago divide must necessarily occupy the same field, it is evident that to avoid duplication of expense, the channel, at least in the expensive rock section,

should be constructed best to meet the requirements of navigation in slope, velocity of current, and dimensions of section, while at the same time of sufficient flowing capacity to carry off the drainage of the sanitary district. Such a compromise will necessarily be more expensive than either a channel best suited for drainage, or a channel best suited and sufficient for navigation. Elsewhere where locks and dams are necessarily used, and in the earth section, it may not seem advisable for the two channels to occupy the same location. The dams will obstruct the flow and the flow will make more expensive the dams and deprive the system of navigation more or less of its slack-water features and advantages. A current aids navigation downstream in direct proportion to its velocity within practicable limits, but obstructs upstream navigation nearly in proportion to its cube. A channel, therefore, with a velocity of 3 miles an hour, or even less, cannot be made equal in value to a similar slack-water channel.

It is doubtful whether there be anywhere on the face of the globe navigation in ordinary river channels by steamboats, upstream, more than 400 miles against a current of 3 miles an hour, or more, and in competition with a good system of land carriage by rail that will pay expenses, much less reduce the cost of transportation, and it must be understood that all water routes between the Great Lakes and the Mississippi River contemplate the transfer of western produce upstream to the Great Lakes, not manufactured and other products downstream westward. It is then evidently of the first importance, if this route is to be used, that the voyage from the Mississippi to the Great Lakes be made as easily and with as little expenditure in time, fuel, oil, and wear and tear as possible. This condition can only be met over this route by slack-water pools or very moderate currents. It cannot be met by 3 miles currents in artificial cuts, or even by large discharges over fixed dams in a river of steep slope, if the channels of this stream be not so greatly enlarged in capacity as to convert the pools approximately into reservoirs.

Under this view, in the report upon the waterway from Lake Michigan to the Illinois River at LaSalle (Annual report Chief of Engineers, U. S. A., 1890, page 2439), the opinion was expressed that a route navigable at all times and conditions could be had, in continuation of the improvement of the Illinois River to Lake Michigan, at practicable cost by a canal from Joliet to LaSalle better than by an improvement in the bed of the river, when a large low water artificial dis-

charge is to be produced and maintained and the artificial discharge uncontrolled at higher stages.

This opinion is, however, contrary to reports of other engineers hitherto made to Congress, and is strongly opposed.

In considering the extension of this route to Lake Michigan, therefore, it seems that it should be investigated in addition to the proper capacity and dimensions of the channel and works of navigation—

(1) Whether this extension should be made from LaSalle to Joliet by the improvement in the bed of the Illinois River or by means of a lateral canal of proper width and depth.

(2) To what extent it is advisable for the United States to co-operate with local authorities in constructing a channel across the Chicago Divide (rock cut) suitable for both local and national purposes, with a view to lessen the cost of construction to each.

(3) Can this be done, and in what way, without increasing the liabilities of the United States for damages to property by flowage from water not necessary for navigation but introduced through channels constructed in whole or in part for public purposes by the United States?

P. 2658.

MM7

Preliminary Examination of Illinois River, Illinois, from La-Salle to the Mississippi River with a view to ascertaining lands subject to overflow by the construction of waterway between Lake Michigan and the Mississippi River.

> United States Engineer Office Chicago, Ill., January 15, 1891.

General:

I have to respectfully report concerning the item contained in the "Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," approved September 19, 1890, relating to a survey of the lower Illinois River, as follows:

Illinois.

Illinois River from LaSalle to the Mississippi River, as recommended by Capt. W. L. Marshall, Corps of Engineers, in his report dated March ten, 1890, with a view to ascertaining what lands would be subject to overflow by the construction of a navigable waterway between Lake

Michigan and the Mississippi River, but not more than Twenty-five Thousand Dollars of the money appropriated

for surveys shall be allotted to this river.

I have to say that as far as any "navigable waterway" recommended by this office is concerned, which work is now in progress and nearly completed on the lower Illinois River, that there will be practically little or no lands overflowed or flooded, and that it is thought that the surveys already made

are sufficient.

I have further to report that it is thought that this item is based upon the following paragraphs of the report upon the "survey of a waterway from Lake Michigan to the Illinois River at LaSalle," published as House Ex. Doc. No. 264, Fifty-First Congress, First Session, relating to a constant discharge from Lake Michigan into the Illinois River for sewage disposal purposes, of from 300,000 to 600,000 cubic feet per minute, on page 33 of that document.

The artificial discharge is not necessary for navigation anywhere along the line, and cannot be said to benefit navigation anywhere to such an extent as to justify the United States Government assuming responsibility for

flowage damage caused by it. P. 2659.

At any little summer freshet, producing a discharge exceeding 8,000 cubic feet per second, at LaSalle, damage by overflow would begin at that point, the artificial discharge being 10,000 cubic feet per second, and with greater natural discharge become more and more widespread as we progressed downstream at times when such overflow would not otherwise occur.

From 100,000 to 300,000 acres of land in the Illinois Valley will be subject to such conditions.

That feature, therefore, in the Chicago Drainage and Waterway laws that requires a constant discharge of from 300,000 to 600,000 cubic feet per minute seems, in view of past experience, decidedly objectionable, if the water is to be introduced through any canal either owned or used by the United States for public purposes, if by such ownership or use the United States can be made responsible for damages due to such constant discharge.

As the State law stands, however, demanding a con-

stant discharge and unnecessarily great and expensive channels neither demanded by nor suitable for the commerce to be subserved, a compliance with its terms does

not seem advisable for the United States.

In view of these facts and laws (Chicago Drainage Laws) a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, i. e., with accurately determined contours at every foot elevation of surface, and with the areas of land subject to overflow well determined, should be made by authority of Congress, before any artificial discharge whatever is turned into the Illinois River, to determine the effects of such artificial discharge and the areas of lands that may be subject under any conditions, to flowage thereby. Such a survey would cost probably \$250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the government of the United States or the city of Chicago.

As the survey recommended by me covers a length of the Illinois River of some 290 miles of bottom lands, densely timbered over a major part of it, and including some 500 square miles or more of area of swamps, lagoons, timbered, and cultivated lands, the amount appropriated (\$25,000) is utterly insufficient to secure the information required and cannot be expended to good purpose if confined to the survey of the character recommended by me in said report, and

spread out over that area.

The Illinois River is worthy of improvement, and its improvement is now in progress. The survey as recommended by me should also be made as a protection for the United States against claims for damages for overflow by water turned into United States channels and over United States dams proposed by the Chicago sanitary district, but the amount appropriated is not more than one-tenth of the amount required to make such survey.

There is certain work, however, that may be done with the amount appropriated that could form part of a complete survey as recommended, and at the same time be of advantage to the improvement of the Illinois River as now being exe-

cuted by the United States Government, viz.:

(1) A line of precise levels from Grafton, near the mouth of the Illinois River, connecting there with the work of the Mississippi River Commission to Lake Michigan, via the Illinois River Valley and the Chicago Divide, with numerous permanent bench marks in the Illinois River Valley as points of departure for the detailed contoured maps recommended.

(2) Any excess of funds over and above what is necessary for this line of precise levels to be applied in making a hydrographic survey of the United States pools created by the dams at LaGrange and (when completed) Kampsville, Illinois, to ascertain the amount of dredging required to complete the present project of improvement.

A further appropriation of \$225,000 to complete the survey

recommended by me will be necessary.

Very respectfully,
W. L. Marshall, Captain, Corps of Engineers.

Brig. Gen. Thomas L. Casey, Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

(First indorsement.)

U. S. Engineer Office Detroit January 20, 1891.

Respectfully Forwarded.

I concur in the views of Captain Marshall, and recommend that he be authorized to apply the appropriation in the manner proposed by him.

O. M. POB. Colonel, Corps of Engineers, But. Brig. Gen. U. S. A. Division Engineer, Northwest Division.

Survey of Illinois River, Illinois, from LaSalle to the Mississippi River, with a view to ascertaining lands subject to overflow by the construction of waterway between Lake Michigan and the Mississippi River.

(Received with letter of Captain W. L. Marshall, Corps of

Engineers, dated July 10, 1891, page 2595.) This work was directed by the river and harbor act of

September 19, 1890, in the following terms:

Sec. 17. That the Secretary of War is hereby directed, at his discretion, to cause examinations or surveys, or both, to be made and the estimated cost of improvement to be estimated at the following location, to-wit:

Illinois.

"Illinois River from LaSalle to the Mississippi River, as recommended by Captain W. L. Marshall, Corps of Engineers, in his report dated March 10, Eighteen Hundred and ninety, with a view to ascertaining what lands would be subject to overflow by the construction of a navigable waterway between Lake Michigan and the Mississippi River, but not more than Twenty-Five Thousand Dollars of the money appropriated for surveys shall be allowed to this river."

The recommendation contained in the report cited was as

follows:

In view of these facts and laws (Chicago Drainage and Waterway Laws), a thorough survey from Joliet to the Mississippi River, at least with the detail shown on the maps of the present survey, i. e., with accurately determined contours at every foot elevation of surface, and with the areas of lands subject to overflow well determined, should be made by authority of Congress before any artificial discharge whatever is turned into the Illinois River to determine the effect of such artificial discharge and the areas of lands that may be subject under any conditions to flowage thereby. Such a survey would cost probably \$250,000, but ultimately save many times that amount to the organization held responsible for such flowage damages, whether it be the government of the United States or the city of Chicago.

As the estimated cost of this survey is \$250,000, and the act limits the expenditure to one tenth of this amount for the contoured survey of from 500 to 750 square miles of territory, densely timbered, swampy, covered with lagoons, and in many places nearly impenetrable, it can at once be seen that the object of the survey cannot be met to any extent by this small

sum.

As far as any project by United States officers for a waterway via the Illinois River is concerned the damages by flowage are already known to be insignificant and that no further surveys to determine them are needed.

. Heade

For such a waterway as contemplated under state laws ten times the amount appropriated, at least, is necessary for re-

sults of value in suits for damages.

The amount allotted can be expended to advantage in carrying a line of precise levels from the Mississippi River to

the Great Lakes, connecting with the levels of the Mississippi River Commission, to serve as a basis for the survey indicated, also in making an hydrographic survey of the pools of the Illinois River to ascertain the amount of dredging required to complete the existing project of improvement and

to form part of the more extended survey.

Before making such uses of this fund it is judged advisable to further submit the matter to Congress in order that such use may be authorized or proper funds be allotted for the survey of the alluvial lands of the Illinois River Valley subject to overflow, or an indication that annual appropriations will be made for the continuance and completion of such a survey as recommended.

Report of Capt. W. L. Marshall, U. S. Engineer at Chicago.
Appendix J. J., Chief of Engineers. Report of 1892. Page 2255.

Improvement of Illinois River, Illinois.

The ultimate object of this improvement is to furnish a through route of transportation by water from the southern end of Lake Michigan to the Mississippi River, of sufficient capacity for its navigation by the largest class of Mississippi River steamboats that can reach the mouth of the Illinois River.

The project now under execution is for the improvement of the lower section of this route, extending from the mouth of Copperas Creek to the Mississippi River, a distance of 137 miles. Another section of the river, 88 miles in length, from the mouth of Copperas Creek to La Salle, has been improved by the State of Illinois by the construction of two locks and dams, one at Copperas Creek and one at Henry, Ill.

Over this latter section the State still collects tolls, the United States not yet having accepted the conditions imposed by the act of cession of the Illinois legislature, which conditions are such as to deprive the works of all value while demanding a great expenditure by the United States Govern-

ment for works to be substituted therefor.

With regard to this subject reference is made to the Annual

Report of the Chief of Engineers for 1889, page 2121, et se-

quitur.

Under the Act of Congress of August 11, 1888, surveys and separate estimates have been made, based upon low-water depths of 8 and 14 feet, for carrying the improvement from La Salle to Lake Michigan via the Illinois and Desplaines Rivers, and a cut across the Chicago divided, over which section there is a fall in water surfaces, Lake Michigan being the summit, of about 141 feet.

The report upon this survey and estimates has been printed as House Ex. Doc. No. 264, Fifty-first Congress, first session, and is also published in the Annual Report of the Chief of En-

gineers for 1890, page 2419 and following pages.

Other surveys and estimates have also been made by the trustees of the sanitary district of Chicago, organized under laws of the State of Illinois, for cutting a capacious channel carrying a large discharge from Lake Michigan into the Illinois River for drainage and sanitary purposes. In the reports of the Chief of Engineers, U. S. Army, for the years 1890 and 1891, the reports and estimates of engineers acting under authority of the city of Chicago, and later under the trustees of the sanitary district of Chicago, relating to this matter will be found. Further reports and estimates from the engineering department of the sanitary district of Chicago are hereto appended.

No provision has yet been made by Congress for embarking upon the construction of the necessary works to establish navigation over the section from La Salle to Lake Michigan, but the legislature of the State of Illinois has provided for the destruction of the navigation established by locks and dams over the section of the Illinois River from La Salle to Copperas Creek, by requiring the removal of the locks and dams at Henry and Copperas Creek within four years of July 1, 1889, whether or not any other system of navigation be substituted therefor. Under this law these dams must be removed

by July 1, 1893.

Page 2258.

The completion of the La Grange Lock and Dam has been followed by a material increase in the tonnage passing La Grange. The completion of the Kampsville Lock and the dredging the channel below it by extending the period of navigation there will have a more marked effect still in increasing

the size and tonnage of vessels navigating the Illinois River and the value of this stream as a means of transportation.

Doubtless the slow improvement of this river has resulted from a difference of opinion as to the method of improvement that should be applied: On the one hand, the necessities of the city of Chicago for better drainage has demanded a large discharge into the Illinois River for sanitary purposes, which discharge would make an open river improvement practicable below La Salle; on the other hand is the fact that the most economical and effective system, as far as navigation is concerned, is that by slackwater, modified, perhaps, by movable dams in the alluvial valley of the Illinois, Lake Michigan being the summit level, the channels being comparatively shallow but of greater width than proposed for sanitary purposes. Additional friction and consequent injury to both the scheme for a navigable channel and to the local drainage measure, delaying both, has been due to the demand by advocates of the latter that the United States shall construct the navigable channel of the dimensions necessary for the drainage scheme, without regard to the most economical channel and speedy method of meeting the absolute requirements of commerce by water over the connecting link between 14,000 miles of interior navigation existing upon the Mississippi River and its tributaries, and the Great Lakes.

These dissensions are now apparently quieted, and without friction the question of the extension of the navigation existing on the Western rivers to the Great Lakes, the best dimensions and location of channel from Joliet to La Salle, and the advisability and conditions of joint use by the United States for navigation and the city of Chicago for drainage of the channel that must be cut for both purposes across the rock in place, from near Willow Springs to near Lockport, can

be now examined.

Upon this subject the reports of the Chief of Engineers for 1889, page 2121 et seq.; for 1890, page 2419, et seq.; and

1891, page 2611 et seq., are referred to.

The authorities of the sanitary district of Chicago have progressed so far with their work as to have definitely located for the third time a part of the drainage channel, and have taken ar additional step in advance by soliciting and receiving proposals for the construction of their channel for drainage across the rock between Willow Springs and Lockport. The prices secured are very favorable; the contract

has not yet been awarded, but the proposals are under advisement by the trustees.

REPORT OF W. H. MARSHALL, U. S. ENGINEER AT CHICAGO, FOUND IN CHIEF OF ENGINEERS REPORTS UNITED STATES ARMY, PAGES 2150-2151. 1894.

The ultimate object of this improvement is to furnish a through route of transportation by water from the southern end of Lake Michigan to the Mississippi River, of sufficient capacity for the navigation by the largest class of Mississippi River steamboats that can reach the mouth of the Illinois River.

The dimensions that have been adopted for the locks to meet

this requirement are:

Length of lock chamber 350 feet Width of chamber 75 Depth of low water over sills

The project now under execution is for the improvement of the lower section of this route, extending from the mouth of Copperas Creek to the Mississippi river a distance of 137 miles. Another section of the river, 88 miles in length, from the mouth of Copperas Creek to LaSalle, has been improved by the State of Illinois by the construction of two locks and dams, one at Copperas Creek and one at Henry, Illinois.

Over this latter section the State still collects tolls, and United States not yet having accepted the conditions imposed by the act of cession of the Illinois legislature, which conditions, if accepted, are such as would deprive the works of all value, while demanding a great expenditure by the U. S.

government for works to be substituted therefor.

With regard to this subject, reference is made to the Annual Report of the Chief of Engineers for 1889, p. 2121, et seq.

Under the act of Congress of August 11, 1888, surveys and separate estimates have been made, based upon low water depths of 8 and 14 feet, for carrying the improvement from LaSalle to Lake Michigan, via the Illinois and Des Plaines river, and a cut across the Chicago divide over which section there is a fall in water surfaces, Lake Michigan being the summit, of about 141 feet.

The report upon this survey and estimates has been printed as House Ex. Doc. No. 264, Fifty-first Congress, first session, and is also published in the Annual Report of the Chief of

Engineers for 1890, p. 2419 and following pages.

In the reports named above and in the Annual Reports of the Chief of Engineers, U. S. Army, for the fiscal years 1891, 1892 and 1893, and in the various reports and estimates made by authority of the trustees of the sanitary district of Chicago, organized under the laws of the State of Illinois, full information relating to the objects and expected results of this improvement, and discussions correlated improve-ments by local authority, may be found.

The existing project involves the construction of two locks and dams in the Illinois River, one at LaGrange 79 miles and the other at Kampsville, 31 miles above the mouth of the Illinois, and dredging the channels from the mouth of Copperas Creek to the Mississippi River, a distance of 137 miles to give 7 feet depth at low water over bars. More than 2,000,-000 cubic yards of dredging in this section is required.

The reach, 88 miles in length, between LaSalle and Copperas Creek, also requires dredging to carry the channel from LaSalle to the Mississippi River.

As far as the construction of locks and dams are concerned, the project is practically completed and in use. The dredging remains to be done, and an efficient snagging service provided.

The depths of navigation under this project, when attained, will meet all the requirements of navigation by Western river steamboats, but until this navigation is extended to the Great Lakes at the southern end of Lake Michigan the improve-

ment will be of comparatively small value.

Congress has so far made no provision for extending the navigation on the same or equivalent basis from LaSalle to Lake Michigan, although repeated surveys and estimates have been made. It is now apparently necessary to consider the question of this extension and the relation thereof to the State works now existing or in process of construction.

Up to this time no satisfactory basis for the transfer of the State works of navigation has been presented by the Illi-

nois authorities.

Extract from a Report of Board of Engineers March 17, 1900.

Appendix MM of Report of Chief of Engineers 1900. Page 3858.

Having considered the available facts bearing upon the questions presented, the Board has the honor to submit the following preliminary report, in compliance with Department letter of February 13, 1900.

The instructions of the Board are found in the act of Con-

gress approved March 3, 1899, as follows:

"The Secretary of War is directed to appoint a board of three engineers, which board shall make a survey and estimates of cost for the improvement of the Upper Illinois River and Lower Des Plaines River, in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago; said board of engineers shall report the estimates of cost for a channel seven feet deep, and also for a channel eight feet deep, throughout said proposed route; said survey and estimates of cost shall be made in pursuance of and according to the recommendations in report of January twenty-seventh, eighteen hundred and ninety-seven, and there is hereby appropriated for the expenses of said board and such survey the sum of thirty thousand dollars, or so much thereof as may be necessary."

The report of January 27, 1897, is a "Preliminary examination of Upper Illinois River and Lower Des Plaines River, Illinois, with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago," made by Maj. W. L. Marshall, Corps of Engineers, U. S. A., and published in the report of Chief of Engineers, 1897, pages 2882-2887.

Detailed reports and surveys have also been submitted to Congress by the following officers:

Gen. J. H. Wilson, 1867, report published in House Ex. Doc. No. 16, Fortieth Congress, first session.

Col. J. N. Macomb, Corps of Engineers, Report of Chief of

Engineers, 1875, Vol. II, page 525.

Maj. W. H. H. Benyaurd, Corps of Engineers, Report Chief

of Engineers, 1884, page 1958.

Board of Engineers on Hennepin Canal and Illinois and Michigan Canal, Report of Chief of Engineers, 1887, page 2125.

Capt. W. L. Marshall, Corps of Engineers, Report of Chief

of Engineers, 1890, page 2419.

The last report covers most thoroughly the entire subject, as far as it had then been developed, considers the various routes, shows the character and location of the works required on each, with detailed estimates of cost, and the 8-foot channel of those estimates is a water-way of so nearly the same dimensions as the 7 and 8-foot channels now called for that the work of the Board might be confined to the presentation of revised plans and estimates derived from this report, if it were not for the change in conditions which has resulted from the construction by the Sanitary District of Chicago of a drainage canal through the divide between Chicago and Lockport. This channel opens a waterway over this part of the route which more than meets the requirements of the one called for or of any other likely to be called for by those interested in navigation.

If the route by the Chicago River and drainage canal be adopted, there remains but little more than half of the work involved in the 8-foot project of 1890 for the Government now to take in hand in order to complete the improvement, since the estimated cost of this portion of the channel (about 28 miles) was nearly \$14,000,000. By the Calumet and Sag route only about 104 miles of the drainage canal can be utilized.

But while the drainage canal covers about half of the work involved in the project by way of Chicago river, it at the same time has turned an additional flow into the Des Plaines River, materially changing its low-water regimen. The requirements of this flow at present are 5,000 cubic feet per second, while the limit of 10,000 is probably more nearly the flow that will have to be dealt with, at least not long after the completion of the present project. As nearly as can now be estimated, this flow gives a water line indicated on the accompanying profile, and the contrast is shown with the low-water conditions hitherto existing. The steep slope shown on the profile indicates that with so large a volume of discharge the velocity of the current would be too great for up-stream navigation in an open river. This might be overcome to a great extent by canalizing the river by high dams, entailing great expenditures for the necessary works, as well as for the purchase of lands overflowed, the cost of which cannot even be approximated from present information.

EXTRACT FROM A REPORT OF MAJOR J. H. WILLARD, U. S. ENGINEER AT CHICAGO, AS TO THE CONDITION OF THE CHICAGO HARBOB AND THE EFFECT OF THE SANITARY DISTRICT CHANNEL. APPENDIX MM REPORT OF CHIEF OF ENGINEERS 1901. P. 2989.

Owing to the general dissatisfaction of the people living along the lake shore between 16th Street and 39th Street with the selection of the inshore dumping ground, by agreement with the proper officer of the city and approved by the Secretary of War, as provided by law, and also to the general objection on the part of the Health Department of the city to the 2-mile ground heretofore acceptable on account of the

danger to the water supply, I am of the opinion that all future dumping should be in accordance with the wishes of the people and the views of the health officers, and be made at least eight miles lakeward and far removed from the city intakes, to avoid all danger of polluting the water supply. This rule should apply, in any event, to all future contracts made by the United States or others for dredging the Chicago River, into which the greatest part of the sewage flows or is planned to flow when the intercepts are finished. The people have paid an enormous sum to divert the sewage from the lake in the interest of the public health, and they feel entitled to protection at the hands of the United States.

Page 2992.

MM 2.

Improvement of Chicago River, Illinois.

This river constitutes the inner harbor of Chicago, Ill. Its navigable parts lie wholly within the city limits of Chicago.

In the annual report of the Chief of Engineers for 1893, page 2974, may be found a full report upon this stream and its needed improvement, and in his annual report of 1897, page 2793, a history of the improvement and some detailed information as to the obstructions to navigation existing along its

channels.

The present project was adopted by Congress in the River and Harbor Act of June 3rd, 1896, and modified by the sundry civil act of June 4, 1897. It contemplates dredging the river and its branches from the mouth of the river to the stockyards on the south branch, and to Belmont Avenue on the North Branch, as far as may be admitted by existing docks and wharves, to allow passage by vessels drawing 16 feet of water; also to acquire title to and cut away certain obstructive bends and projecting docks that narrow and obstruct the channel.

Since the flow of the Chicago River has been reversed through the South Branch by the discharge into the Sanitary Canal, the slope has also been reversed from the lake upstream, and the depth correspondingly reduced. To compensate for this loss in navigable depth the sanitary trustees have undertaken to dredge to a depth of 26 feet below hydraulic grade, and will continue to dredge to that depth while enlarging the river to 200 feet width upon plans approved by the Secretary of War. To reduce the dangers to navigation by the upstream flow, and to provide for the discharge of 20,000

cubic feet per minute for each 100,000 inhabitants of the Sanitary District, as required by State law, the trustees have submitted plans for seven bascule bridges, which have been approved by the Secretary of War upon the recommendation of the Chief of Engineers.

P. 3006.

MM 5.

Improvement of Illinois River, Illinois.

The object of this improvement is to secure ultimately, in connection with an enlargement of the Illinois and Michigan Canal, or an equivalent enlarged canal, a waterway from the southern end of Lake Michigan to the Mississippi River of sufficient capacity for large-sized Mississippi River steam-

boats and for military and naval purposes.

The present project was adopted in 1880, and contemplates the extension of the slack-water improvement begun by the State of Illinois from the mouth of Copperas Creek to the Mississippi River at Grafton, Ill., a distance of 135 miles. The project includes the construction of two locks, each 350 feet in length of chamber, 75 feet in width, and with 7 feet depth at low water over sills, and dredging the channel where necessary to secure that depth of water at low water throughout the pools created by the dams.

The locks and dams have been completed and have been in use since 1889 and 1893, respectively. One is situated at La-Grange, 79 miles above the mouth of the Illinois, the other at

Kampsville, 31 miles from the Mississippi.

The State of Illinois, aided by the United States, has executed part of the general project by the construction of locks and dams at Hennepin and Copperas Creek, completing, except dredging, that part of the project between LaSalle and the mouth of Copperas Creek, a distance of about 90 miles, over which section the State of Illinois collects tolls.

In executing this work the United States has expended prior to June 30, 1897, \$1,344,090.62, including \$25,000 from appropriation of August 11, 1888, for surveys, and exclusive of \$62,-359.80, expended upon a foundation for Copperas Creek Lock, afterwards completed by the State of Illinois, and since that date in dredging, care and repair of plant, etc., \$86,065.10, making a total expenditure on this work to June 30, 1901, of \$1,430,155.72.

The State laws authorizing the construction of the Sanitary Canal require the removal of the state dams, when the flow required by the state law of 20,000 cubic feet per minute for each 100,000 inhabitants of the Sanitary District shall have become permanent, the expectation being that the increased discharge would furnish an open navigation equivalent to that pooled by the dams. The discharge of the sanitary canal, however, is regulated by the Secretary of War insofar as it affects the interests of navigation in the Chicago River, and has been reduced by his order to 200,000 cubic feet per minute until the South Branch shall have been widened and deepened sufficiently to permit the full flow required by the state law, or so much thereof as may be found safe.

Unless, therefore, a large amount of dredging is done in the Henry and Copperas Creek State pools, the compensated navigable depth is not likely to be gained, the discharge through the openings in the dams most probably pulling the new water line below present crest heights throughout both

pools.

The United States has a general interest in this question because it has spent large sums in extending the navigation of the river, but it has a direct interest in the effect the change must have on the LaGrange pool. This should be surveyed and dredged before the Lower State Dam is removed; otherwise the navigable length of the LaGrange pool must be shortened.

But if the results should approximate the theories of those advocating the removal of the State Dams, Congress would be asked to authorize the removal of the United States dams and

thus convert the Illinois into an open river again.

Congress has indicated its purpose to have a thorough survey of the river for a deep waterway, but whether that is done soon or not at all, the War Department should begin collecting information in anticipation of a demand for removing the United States dams. I am not authorized to recommend a survey, but it is not improper to say that precise levels are absolutely necessary to a proper study of the questions that will arise in the near future. A duplicate line between Chicago and the mouth of the Illinois River would require two seasons' work, and would cost \$10,000, including instruments, monuments, etc., and would furnish the basis for any future surveys that should be required, whether general or local.

I am of the opinion that an open river with a low-water navigable depth equivalent to that now furnished cannot be obtained except by dredging on a large scale with the most approved hydraulic plant. The dredging now in progress is only that necessary to furnish a low-water depth of 7 feet in

the pools.

Final Report on Survey of Upper Illinois and Lower Des Plaines Rivers, Illinois, with a View to the Extension of Navigation from Illinois River to Lake Michigan at or Near Chicago.

(Printed in House Doc. No. 112, Fifty-Sixth Congress, Second Session.)

Office of the Chief of Engineers United States Army,

Washington, December 4, 1900.

Sir: The river and harbor act approved March 3, 1899,

contains the following item:

Illinois river and Des Plaines river, Illinois: The Secretary of War is directed to appoint a board of three engineers, which board shall make a survey and estimates of cost for the improvement of the Upper Illinois River and Lower Des Plaines River, in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago; said board of engineers shall report the estimates of cost for a channel seven feet deep, and also for a channel eight feet deep, throughout said proposed route; said survey and estimates of cost shall be made in pursuance of and according to the recommendations in report of January twenty-seventh, eighteen hundred and ninety-seven, and there is hereby appropriated for the expenses of said board and such survey the sum of thirty thousand dollars, or so much thereof as may be necessary.

Preliminary report dated March 17, 1900, by the board of engineers appointed by authority of the Secretary of War in accordance with requirements of the above-quoted item of law, was submitted to the Secretary of War with my letter of March 24, 1900, and is printed in House Doc. No. 548, fifty-sixth Congress, first session, and in my Annual Report for

1900, page 3856 et seq.

I have now the honor to submit the accompanying copy of the Board's final report on the subject dated November 17,

1900.

The plans presented are for waterways of seven and eight feet depth from Utica to Marseilles in the bed of the river, thence around the Marseilles Rapids by canal, thence in the bed of the river to near the mouth of the Kankakee, thence through the Illinois and Michigan Canal to the Joilet basin, thence by canal to the Sanitary Canal at Lockport, and thence via the

Sanitary Canal and Chicago River to Lake Michigan. These projects involve the construction of 12 locks and 2 dams with movable weirs, the estimated cost being:

For the 7-foot project......\$7,317,977

franchises as are necessary in connection with the constructions contemplated will be ceded free of cost to the United States.

The cost of an independent 8-foot waterway from Sag Bridge on the Sanitary Canal to Lake Michigan via the Little Calumet and Calumet Rivers (the Sag Route) is estimated at \$5,680,186, making a total of \$14,333,433, as the estimated cost

of an 8-foot waterway via the Sag route.

Very respectfully,

Your obedient servant, JOHN M. WILSON,

Brig. Gen. Chief of Engineers, U. S. Army.

Hon. ELIHU ROOT, Secretary of War.

Page 3049.

Report of Board of Engineers. Chicago, Ill., November 17, 1900.

General: The Board of Engineer officers constituted by paragraph 1, special orders, No. 14, March 12, 1899, headquarters Corps of Engineers, United States Army, in accordance with the provisions of the Act of March 3, 1899, to make "a survey and estimates of cost for the improvement of the Upper Illinois River and Lower Des Plaines River, ir Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago," submitted a preliminary report March 17, 1900, with estimates for channels eight feet deep and seven feet deep. (House Doc. No. 548, 56th Congress, 1st session.) The Board reconvened at Chicago November 9, 1900, and having revised its estimates after fuller information now presents its final report.

The Board finds the most economic route for waterways of 7 feet and 8 feet depth to be from Utica to Marseilles in the bed of the river, 11.4 miles; thence around the Marseilles rapids by canal, 7.4 miles; thence in the bed of the river to near the mouth of Kankakee River, 21.2 miles; thence by enlarging the Illinois and Michigan Canal to the Joliet basin, 18.3 miles; thence by canal through Joliet Basin and along the east bank of the Des Plaines River, 41 miles, connecting with the Sanitary Canal at Lockport, and thence through the Sanitary Canal and the Chicago River to Lake Michigan, thus complying with

the terms of the Act of March 3rd, 1899.

For the 8-foot project the dimensions proposed for the river sections and canal from Utica to the mouth of the Des Plaines River are not less than 300 feet wide at bottom for the river divisions and not less than 170 feet surface width for canal, with depths in the river divisions of 8 feet below extreme low water and in the canal of 10 feet. Existing railroad and highway bridges over these divisions must be remodeled to give suitable draw openings over the proposed channels. With locks of the same dimensions as the United States and State locks now in operation in the Lower Illinois River, viz., 75 feet wide by 350 feet between miter sills, steamboat navigation will be extended to the head of the Illinois River.

For the remaining canal divisions the width will not be less than 130 feet at water surface and the depth 10 feet, but the locks are reduced to 40 feet width by 260 feet between miter sills. With fixed bridges giving 22 feet headroom, the Board is of the opinion that these dimensions should furnish ample navigation for the largest barges heretofore in use on the Mississippi River, and that the combination will afford a waterway of 10 feet depth at stages 2 feet above extreme low water in the Illinois River of sufficient capacity for any through

barg traffic likely to seek it.

To overcome a mean difference of elevation of 133 feet between the river surface at Utica and the surface of the Sanitary Canal at Lockport, with allowances for variations in stages at either end of the route, 12 locks have been provided as follows:

Locks 75 by 350 feet—Utica River Division: One lift lock, 15 feet lift. Marseilles Canal: Two lift locks, each 15 feet

lift; one guard lock.

Locks 40 by 260 feet—Canal to Joliet Basin: Three lift locks, each 15 feet lift; one lift and guard lock, 15 to 9 feet. Canal, Joliet Basin to Lockport: Two lift locks, each 12 feet lift; one lift lock, 10 feet; one lift and guard lock, 10 feet to zero.

Two dams will be required, one at Utica and one at the head of the Marseilles Canal. The board is of the opinion that both dams should be surmounted by some form of movable weir to reduce the elevation of flood discharge by an amount at least equal to that which has been caused by the additional discharge from the Sanitary Canal.

The 7-foot waterway will follow the same route as that for

8 feet, and the dimensions of river channels, canals and locks will be the same except in depth. This will furnish a 9-foot navigation at a 2-foot stage in the Illinois River to the mouth of the Des Plaines River and a through barge navigation to Lake Michigan at Chicago. The principal reduction in the estimates is in the amount of excavation, the dimensions permitting little change in the cost of locks and other structures.

Estimates.

Utica Division.

	7-foot	8-foot
	project	project
Dam and movable weir,	\$106,000	\$106,000
1 lock,	307,807	317,575
River walls,	57,098	57,098
Levees,	69,667	69,667
Excavation, rock,	73,250	210,125
Marseilles Canal:		
3 locks,	616,343	645,247
River walls,	105,282	105,282
Levees,	16,410	16,410
Excavation,	446,455	494,396
Revetment,	45,500	45,500
Kenkakee pool:		
Dam and movable weir,	146,000	146,000
Excavation.	65,375	156,025
Enlarging Illinois & Michigan Canal:		
4 locks,	561,212	584,578
Excavation, rock,	77,598	778,876
Excavation, earth,	402,094	353,426
Culverts,	75,000	75,000
Aqueduct,	100,000	105,000
Canal Joliet to Sanitary Canal:		F10 100
4 locks,	487,798	512,490
Excavation, rock,	234,675	327,594
River walls,	464,750	464,750
Culverts,	75,000	75,000
Bridges,	865,000	865,000
Right of way and damages,	700,000	700,000
Engineering and contingencies, 20%,	1,219,663	1,442,208
Total.	7,317,977	8,653,247

As in the preliminary report, the Board invites attention to the fact that the estimates are based upon the assumption that

14.333,433

the State of Illinois and the sanitary trustees of the City of Chicago will cede the necessary parts of their respective franchises free of cost to the United States, both for construction and use.

The Sag Route. Since the Board's report of March 17, 1900, the trustees of the sanitary district have undertaken to co-operate with the United States in deepening the South Branch of Chicago River to 21 feet and widening it to at least 200 feet. They have already planned to substitute 7 bascule bridges for the center-pier bridges now obstructing the river. It is expected that this project will be extended, and that the City of Chicago will undertake a part of the bridge reconstruction and lower, or cause to be lowered, the three tunnels now limiting the navigable depth of the river to 17 feet. The fears entertained with respect to the dangers of navigating the South Branch of the river under the new conditions of reversed flow have been allayed to a great degree by the practical experience of the past season. For this reason, and because the plans for both the 7-foot and 8-foot waterways comply with the requirements of the act contained in the words "with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago" in connection with the Sanitary Canal, the Board is of the opinion that the additional cost will not justify the construction at the present time of an auxiliary canal from the Sanitary Canal to Lake Michigan by way of the Sag and Calumet Route, and is also of the opinion that such a route would not become a necessity until the commerce of either the 7-foot or 8-foot route should develop to a degree not expected for years.

The estimates for this auxiliary route are based upon the

The estimates for this auxiliary route are based upon the same dimensions for canal and structures as those for the canal from the Illinois River to Lockport in the 8-foot project.

Estimate for the Sag Route. 1 lock connecting with Sanitary Canal at Sag	
Bridge,	\$155,000
Rock excavation,	603,800
Earth excavation,	1,924,688
Bridges,	1,500,000
Right of way,	550,000
Engineering contingencies, 20 per cent.,	946,698
Total, Grand total for 8 foot waterway by the Sag	5,680,186

Grand total for 8-foot waterway by the Sag route, The report of Assistant Engineer James A. Seddon, is appended, and there accompanies the report an index map with profile and 19 maps of the route from the Sanitary Canal at Lockport to LaSalle on the Illinois River.

Money Statement.

Amount appropriated by act approved March 3, 1899,	\$30,000
Amount expended to November 17, 1900, Outstanding liabilities, Balance available,	22,155.88 3,044.12 4,800.00
	30,000,00

Respectfully submitted,
J. W. Barlow,

Colonel, Corps of Engineers.
J. H. WILLARD,

Major, Corps of Engineers.
C. Mod. Townsend,

Major, Corps of Engineers.

Brig. Gen. John M. Wilson, Chief of Engineers, U. S. A.

EXTRACT FROM A REPORT OF MR. JAMES A. SEDDON, ASSISTANT ENGINEER. PAGE 3052.

United States Engineer Office,

Chicago, Ill., November 9, 1900.

Colonel: In accordance with the instructions of the Board of Engineers, I have the honor to report upon the location of waterways for 7-foot and 8-foot navigation, with estimate of cost.

Under the terms of the Act of March 3, 1899, these waterways are required for an extension of the navigation of Illinois River through the Upper Illinois and Lower Des Plaines

to Lake Michigan at or near Chicago.

The Sanitary Canal having been opened in accordance with the State law and under a provisional permit from the Secretary of War, the flow of the Des Plaines and Illinois Rivers has been increased by a discharge of 5,000 cubic feet per second, which will be raised to the maximum of 10,000 cubic feet per second under the provisions of the State law authorizing the construction of the Sanitary Canal. P. 3059.

REPORT OF BOARD OF ENGINEERS.

United States Engineer Office, Chicago, Ill., November 18, 1900.

General: The river and harbor act approved June 6, 1900,

provides-

"That the board of three engineers appointed by the Secretary of War, in pursuance of a paragraph in the river and harbor Act approved March 3rd, Eighteen Hundred and Ninety-nine, to make a survey and estimates of cost of the improvement of the upper Illinois River and the lower Des Plaines River in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near the city of Chicago, is hereby authorized to report the estimates of cost for a channel 10 feet deep, and for a channel 12 feet deep, and for a channel 14 feet deep through said proposed route, and that the said estimates cover and include a proper connection at Lockport with the sanitary and ship canal which has been constructed by the sanitary district of The said board of engineers is also further authorized to make a survey and estimate of cost for the improvement of the Lower Illinois River from the end of said proposed route to the mouth of said river, for channels 10, 12, and 14 feet deep, respectively, and to report the estimates of cost thereof: And provided further, That surveys and estimates of cost shall be made in pursuance of the provisions contained in the Act aforesaid and especially in accordance with section twenty-two of said Act: And provided further, That said surveys shall be commenced and the expenses for said surveys and reports shall be paid as follows: Any unexpended balance of the appropriations of Thirty thousand Dollars not required for the completion of the survey already contained in said Act shall be first applied and used, and no further expense shall be incurred for such estimates and surveys without the further direction of Congress, and the Secretary of War shall ascertain and report to Congress what amount of money shall be required to complete said surveys and estimates of cost."

In compliance with your instructions in accordance therewith, contained in Department letter dated June 11, 1900, the Board has the honor to submit the following preliminary re-

port:

Section 22 of the river and harbor act approved March 3, 1899, under which surveys and estimates are to be made, is as follows:

That the Secretary of War is hereby directed to cause preliminary examinations or surveys to be made at the localities named in this section as hereinafter provided. In all cases a preliminary examination shall first be made, which shall embrace information concerning the commercial importance, present and prospective, of the river or harbor mentioned, and a report as to the advisability of its improvement. Whenever such preliminary examination has been made, in case such improvement is not deemed advisable, no further action shall be taken thereon without the direction of Congress; but in case the report has been or shall be to the effect that such river or harbor is worthy of improvement, the Secretary of War is hereby directed at his discretion, to cause surveys to be made and the cost of improving such river or harbor to be estimated and to be reported to Congress.

It therefore devolves upon the Board to express its opinion as to the advisability of the improvement before surveys can be undertaken. As Congress has approved the project for the improvement of the Illinois River from its mouth to LaSalle, providing for a depth at low water of 7 feet, and authorized surveys to determine the cost of obtaining waterways with depths of 7 and 8 feet from LaSalle to Lake Michigan, at or near Chicago, upon which we have submitted a report dated November 17, 1900, the question now before the Board is the advisability of a further enlargement of this

waterway to depths of 10, 12 and 14 feet.

The preliminary examination of the Lower Illinois River from Grafton to Peru was made by members of the Board on the Steamer Reindeer, chartered for the purpose August 2 to 4, 1900. The Board had also examined the portions of the route from the end of the Drainage Canal at Lockport to the mouth of the Des Plaines River and the rapids at Marseilles, in connection with the survey for determining the cost of the 7 and 8 foot waterways along the Upper Illinois and Des Plaines Rivers.

The present commerce of the Lower Illinois River practically all terminates at St. Louis, and the traffic of the river is represented by the Illinois River freight received and shipped at that point. There is appended a statement of the receipts and shipments at St. Louis of Illinois River freight

for the past 8 years, derived from the reports of the Mer-chants' Exchange of St. Louis. This commerce averages

44,425 tons per annum. (Appendix 1.)

While the Upper Illinois and Des Plaines Rivers are at present non-navigable, the commerce of the Illinois and Michigan Canal which has been constructed in the valleys of these rivers may be taken to represent the present commerce of such a route. The tonnage carried on the Illinois and Michigan Canal since 1860, derived from the Reports of the Board of Trade of Chicago is also appended. (Appendix 2.)

To determine the prospective commercial importance of the proposed route an expression of opinion was invited from those interested, who had made the matter a subject of special study. There accompany this report the papers submitted:

Memoir of the trustees of the sanitary district of Chi-

cago.

B. Commercial utility of a waterway of a navigable depth of not less than 14 feet between Chicago and St. Louis, brief by Lyman E. Coolev.

C. Paper on a deep waterway from the Great Lakes to the Gulf of Mexico, presented by the Illinois River Valley Asso-

ciation.

The commerce of the waterways of the Illinois and Des Plaines Valleys is small and has been diminishing in recent years. It is not sufficient to warrant any increase in existing navigable depths, and it is only by considering the develop-ment of a connecting link between the system of river commerce in the Mississippi Valley on the one hand and the commerce of the Great Lakes on the other that even a waterway with a depth of 8 feet will be justified.

The adopted projects for the improvement of the Mississippi River provides from the mouth of the Illinois River to the mouth of the Missouri "for a channel of a depth of four and a half feet of low water, to be eventually increased to six feet"; from the mouth of the Missouri River to St. Louis "eventually a minimum depth at standard low water of six feet, and of eight feet from St. Louis to the mouth of the Ohio," and below the mouth of the Ohio ten feet at low The projects for the improvement of all the tributaries of the Mississippi, except the Illinois River, provide for waterways of not exceeding six feet at low water.

The project for the Lower Illinois River provides for locks

75 feet wide and 350 feet between miter sills with 7 feet on the miter sills at low water. The discharge of the Chicago Drainage Canal should increase the navigable depth to over 8 feet, and if the project be extended to Lake Michigan by the 8 foot project on which estimates have been submitted by the Board, there will be afforded a connecting link between the Great Lakes and the Rivers of the Mississippi Valley, not only ample for river navigation as it now exists, but also for any improvement therein that has been authorized by Con-

gress.

But it is held by not a few that the United States should take the initiative and construct a great waterway of which the Illinois Valley line should be a link, extending lake navigation to the interior of the country, and that a commerce which does not now exist will then develop to such a magnitude as will more than justify the expenditures. For such a project a depth of 14 feet or greater will be required, and further surveys and estimates for a waterway of less depth than 14 feet cannot be considered by the terms of Section 22, under

which the Board is instructed to act.

The engineering questions presented in a project for a deep waterway to connect Lake Michigan with the Illinois River, although attended with considerable difficulty, are by no means insuperable. The proposed line would embrace, first, the Chicago River, consisting of the main river and a portion of the South Branch for a distance of about 5 miles. This section is now under improvement by the United States in co-operation with the trustees of the Sanitary District of Chicago, and will, when the many changes in bridges and tunnels have been made, and the widening and deepening of the channel completed, afford a navigable depth of 21 feet and an available width of 200 feet.

Connecting with this section the sanitary canal affords a magnificent waterway, 28 miles in length, of sufficient depth

and width for any possible requirement of navigation.

From the west end of this canal the waters of Lake Michigan, in a steady flow amounting to from 5,000 to 10,000 cubic feet per second, are discharged into the bed of the Des Plaines River, and are carried thence down through the Illinois to

the Mississippi.

The velocity of current along the Des Plaines river, which would have resulted from confining this discharge to a channel of 8 feet depth for barge navigation, will be sufficiently reduced in a ship canal of 14 feet depth or over to make upstream navigation feasible. On the lower Illinois River the prevailing slope of less than 0.15 foot per mile will insure

so gentle a current that the depth required can be secured simply by enlarging the existing waterway by dredging in an alluvial deposit, at a cost which will be small when compared with the work which has been done by the city of Chicago in cutting through the divide between the Lake Basin and the Illinois Valley watershed, so eloquently described in the memoir of the Board of Trustees of the Sanitary District of

Chicago.

But such a channel to be of commercial value should either form a through line of communication between the lakes and the Gulf of Mexico or extend to some large center of population, as St. Louis. A waterway stopping at the Village of Grafton would have little commercial importance, except locally, over one to the present terminus of the Drainage Canal at Lockport. The terminal arbitrary described by Mr. Cooley in his paper submitted will be as applicable in the one case as in the other.

The commercial possibilities of navigation by lake vessels to St. Louis and the Gulf of Mexico have been ably discussed in the papers accompanying this report, but all of these projects are based upon the assumption that the Mississippi River can be rendered navigable for such vessels. The feasibility of the development of the navigation of the Mississippi River is the essential element, which must first be determined before any project for extending lake navigation inland can be considered advisable.

REPORT OF COL. O. H. ERNST, U. S. ENGINEER AT CHICAGO, ON THE IMPROVEMENT OF THE CHICAGO RIVER. APPENDIX KK—REPORT OF CHIEF OF ENGINEERS, 1902. Page 2097.

K K 2.

Improvement of Chicago River, Illinois.

This river constitutes the inner harbor of Chicago, Ill. Its navigable parts lie wholly within the city limits of Chicago.

In the Annual Report of the Chief of Engineers for 1893, page 2974, may be found a full report upon this stream and its needed improvement, and in his annual report for 1897, page 2793, a history of the improvement and some detailed information as to the obstructions to navigation existing along its channels. At the beginning of the fiscal year the project was nearly completed, there remaining to be done only the final approval by the Attorney-General of the title

to one of the tracts, and the excavation by dredging of two tracts. The last excavation was completed August 28, 1901.

Since the flow of the Chicago River has been reversed through the South Branch by the discharge into the sanitary canal the slope has also been reversed from the lake upstream and the depth correspondingly reduced. This loss in navigable depth will be more than restored in the main stream and in the South Branch by the excavations of the sanitary district, which, in order to facilitate the flow of the large volume of water required for the dilution of the sewage discharged into drainage canal, has undertaken to enlarge these portions of the Chicago River to a width of 200 feet and central depth of 26 feet. These dimensions have no relation to the draft of vessels using the river, and if maintained as they should be for drainage purposes will furnish a navigable depth in excess of the requirements. The south fork of the South Branch, and the North Fork, however, do not share in these benefits. In the South Fork particularly the dimensions of channel obtained by the operations of the Government were seriously impaired by the change of slope. The sanitary district has undertaken to restore these dimensions. and will no doubt do so, though it has been prevented from fully accomplishing the work by some difficult rock excavation. But it has not undertaken as yet to maintain them.

The Chicago River is the main sewer of Chicago, and as such is subject to deteriorating influences as a navigable channel from which there is no escape. The city ordinances against dumping solid matter into it are ample, and, I think, generally well observed. But a very large amount of solid matter must of necessity go into it with a perfectly legitimate use of it as a sewer. Periodical dredging will be necessary to maintain it as a navigable channel and, eventually, to maintain it even as a sewer. That work would seem to be as much the duty of the city as the maintenance of any other part of its sewer system. So far as the South Branch is concerned, the question has been solved by the necessities of the drainage canal, as already mentioned, but the sanitary district has not accepted responsibility for maintaining the other branches. Whether that organization or some other representing the people of Chicago should do the work is for them to decide, but it seems to me clear that the United States should not be called upon to do it. Accordingly, no estimate for maintaining the channel

excavated under the project of 1896 is submitted.

The river and harbor act of June 13, 1902, contained the following item, viz.:

Improving Chicago River, Illinois: Continuing improvement, three hundred and six thousand four hundred and fifty-seven dollars: Provided, That the sum of one hundred and ninety-three thousand five hundred and forty-three dollars, unexpended balance of money heretofore appropriated for the improvement of the Chicago River, making the total sum five hundred thousand dollars, may be used in the improvement of said river by constructing turning basins of proper size in said river, said turning basins to be located by, and said money to be expended under the direction of, the Secretary of War.

It is proposed to apply these funds to the acquisition of the necessary land and to the excavation of two turning basins, one on the South Branch near its junction with the South Fork and West Fork, and the other on the North Branch near the

head of Goose Island.

It is probable that the amount available will be sufficient to create those turning basins, though their exact cost cannot now be given. No additional appropriation is asked for, but it is suggested that all of the "unexpended balance of money heretofore appropriated for the improvement of the Chicago River" be made available for the turning basins. That was no doubt the intention of the present law, quoted above. But this law specified the amount of the unexpended balance as \$193,543. It was estimated a year ago that that would be the amount unexpended after the closure of existing contracts. As a matter of fact, the unexpended balance June 30, 1902, is \$201,497.61, which is \$7,954.61 more than the estimate of a year ago. There is no good reason why the whole of this balance should not be made available for the turning basins.

The volume of business transacted in the river during the calendar year 1901 was slightly larger than in the previous year, but with that exception it was less than in any year since 1893, as appears from the comparative statement attached to my report on Chicago Harbor herewith. The commodities received and shipped by lake were in 1901 6,184,242 tons against 7,958,963 tons in 1893, and this notwithstanding the great revival of business activity since 1893. This decline has been steady and is bound to continue unless the obstructions to navigation in the river are removed. The people of Chicago, through the officials of the sanitary district, are doing good work in that direction, and are engaged in a systematic and extensive system of improvements in the South Branch, widening and deepening the channel and remodeling the bridges.

These improvements are of great value and importance, and of necessity as well, but they will accomplish little without the removal of the tunnels under the river. These tunnels now have about 17 feet of water over them and limit safe navigation to a draft of 16 feet. The attitude of Congress toward them is that they are legal structures, and until removed by the authority which placed them there—the City of Chicago they limit the extent to which the river can be improved. No lake port which cannot safely accommodate vessels drawing more than 16 feet can hold its own in these days of deep-draft vessels. The evil which these tunnels are doing does not seem to be fully appreciated by the people. The bridges and narrow channels are obstructive, but the tunnels absolutely close the door to the best class of vessels. Chicago will do well to remove the tunnels without further delay if she is to arrest the decay in her lake shipping, which has been going on almost continuously for the last ven years.

54th Congress, 2d Session. House of Representatives. Document No. 333.

PRELIMINARY EXAMINATION OF THE UPPER ILLINOIS RIVER AND LOWER DES PLAINES RIVER, ILLINOIS.

Letter from the Secretary of War, Transmitting, with a Letter from the Chief of Engineers, a Report of a Preliminary Examination of the Upper Illinois River and Lower Des Plaines River, Illinois.

March 2, 1897.—Referred to the Committee on Rivers and Harbors, ordered to be printed.

War Department,

Washington, D. C., March 3, 1897.

Sir: I have the honor to enclose herewith a letter from the Chief of Engineers dated March 2, 1897, together with a copy of a report from Maj. W. L. Marshall, Corps of Engineers, dated January 27, 1897, of a preliminary examination made by him in compliance with the provisions of the river and harbor act of June 3, 1896, of the upper Illinois River and lower Des Plaines River, Illinois.

Very respectfully,

DANIEL S. LAMONT, Secretary of War. The Speaker of the House of Representatives.

Office of the Chief of Engineers,

United States Army,

Washington, D. C., March 2, 1897.

Sir: I have the honor to submit the accompanying report of January 27, 1897, by Maj. W. L. Marshall, Corps of Engineers, of the results of a preliminary examination of the upper Illinois River and lower Des Plaines River, Illinois, with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago, made in compliance with requirements of the river and harbor act of June 3, 1896.

Major Marshall states that the locality embraces an important commercial route between the Great Lakes and the Mississippi River system, and its utility and worthiness have long been recognized by Congress.

The division engineer, Col. Henry M. Robert, Corps of Engineers, is of the opinion that the upper Illinois and lower Des Plaines rivers are worthy of improvement, and I concur in his views.

It is estimated that the cost of the necessary survey and preparation of detailed plans of improvement will be \$75,000.

Very respectfully, your obedient servant,

John M. Wilson,

Brig. Gen., Chief of Engineers, U. S. Army. Hon. Daniel S. Lamont, Secretary of War.

PRELIMINABY EXAMINATION OF UPPER ILLINOIS RIVER AND LOWER DES PLAINES RIVER, ILLINOIS, WITH A VIEW TO EXTENSION OF NAVIGATION FROM ILLINOIS RIVER TO LAKE MICHIGAN AT OR NEAR CHICAGO.

United States Engineer Office,

Chicago, Ill., January 27, 1897.

General: In accordance with your letter dated August 11, 1896, I have the honor to submit the following report upon a preliminary examination of "the upper Illinois River and lower Des Plaines River, with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago," directed by the river and harbor act of June 3, 1896.

2204

The latter reports are in so full detail that little can now be added to them by any preliminary examinations, as such are understood by me, and all that can be submitted now is simply a repetition of a small part of the information contained in these reports, with a brief statement of the conditions brought about by local engineering works constructed for drainage purposes by the trustees of the sanitary district of Chicago.

The sanitary district of Chicago has nearly completed a canal for drainage purposes from Chicago River at Robey street to near Lockport from 18 to 22 feet in depth below the proposed water surface, and varying in width from 160 feet in rock to more than 200 feet in earth, a length of 28 miles. which may be made available as part of any enlarged waterway over the route in question, and is of much greater dimensions than required by any commerical canal adapted for the conditions and requirements of present or prospective traffic by water between Lake Michigan and the region along the water courses of the Mississippi Valley. To comply with the law of the State of Illinois under which this drainage canal is constructed—it has been constructed of a capacity to discharge 600,000 cubic feet per minute through the section excavated in rock and 300,000 cubic feet per minute throughout the earth section-the law requires a discharge of 20,000 cubic feet per minute for each 100,000 inhabitants of the drainage district, which at present requires more than 300,000 cubic feet and in a few years will require the full 600,000 cubic feet discharge through the canal. The taking of water from Lake Michigan, however, for drainage purposes (or rather for dilution of sewage) has not yet been authorized by Congress. This deep channel abruptly terminates at Lockport, and it is proposed to discharge the water through controlling gates into a non-navigable tail race down the slope to and through the City of Joliet into the lower Des Plaines and Illinois rivers. Any navigable channel, therefore, constructed in continuation of the drainage canal must connect with this canal at Lockport and terminate at or above LaSalle, about 66 miles distant, but the lockage after the opening of the drainage canal will be reduced by at least the amount that the increased discharge will raise the water surface of the Illinois River at LaSalle, increased by the slope in the drainage canal from Lake Michigan to Lockport, or, say, at least 12 feet when the drainage canal is actually discharging. This will result in reducing the number of locks required in any of the proposed schemes by one, but will substitute an obstruction due to the current in the canal and river, repeated in each pool of the river, if the natural channel be improved.

The trustees of the Chicago sanitary district are constructing their canal with fixed bridges with 22 feet clear headroom over the canal. This is ample headroom for a commercial barge canal of the largest capacity, and the difference in cost between fixed and drawbridges crossing the canal between Chicago and Lake Joilet, with a reasonable allowance for difference in cost of operation, is probably sufficient to construct the canal from the present terminus of the drainage canal to Lake Joliet of from 8 to 10 feet depth, with locks suitable for the passage of the largest Mississippi River barges. Mississippi River towboats could then carry their tows to Lake Joliet, then transfer them to more handy tugs for passage through the more obstructive canal portion of the route. For an 8-foot channel from Lockport to Lake Joliet the estimated cost in 1890, exclusive of bridges, was \$3,900,000. Swing bridges from Chicago to Lake Joliet were estimated at \$3,653,000. The cost of operating the swing bridges would far exceed the cost of operating the locks without any corresponding advantages for a commerical canal, other than sentimental. over the part of the route where towing on the Mississippi River style cannot be applied.

Conclusion.

1. In my opinion the surveys already made are in sufficient detail for preliminary estimates of the cost of any suitable extension of the navigation of the Illinois River to Lake Michigan that does not involve enlargement of the Illinois and Michigan Canal from Joliet to LaSalle.

2. That prior to embarking in any such improvement it is advisable to secure from the State of Illinois the State works along the Illinois River and such parts of the Illinois and Michigan Canal as may be utilized; also to thoroughly complete the lower Illinois River improvement which has slowly progressed for thirty years, resulting in diversion of water traffic to rail.

3. That the dimensions and route of the proposed extension should be examined into and decided by a competent board of engineers, with means and authority to make such additional surveys as their proper enlightenment demands. The expenses and costs of such a board of the surveys are estimated at \$30,000; if detailed plans, etc., are to be made, at \$75,000.

The locality embraces an important commercial route between the Great Lakes and the Mississippi River system, and its utility and worthiness has long been recognized by Congress.

Preliminary estimates of cost on various plans have been heretofore made, and reports containing them are referred to

hereinbefore.

Very respectfully, your obedient servant, W. L. Mabshall, Major, Corps of Engineers.

Brig. Gen. W. P. CRAIGHILL,

Chief of Engineers, U. S. A.

(Through the Division Engineer.)

(First indorsement.)

U. S. Engineer Office, Northwest Division,

New York, February 20, 1897. Respectfully forwarded to the Chief of Engineers, United

States Army.

I am of the opinion that the upper Illinois and lower Des Plaines rivers are worthy of improvement with a view to extension of navigation from Illinois River to Lake Michigan at or near Chicago.

Henry M. Robert, Colonel, Corps of Engineers, Division Engineer. EXTRACT FROM A PAMPHLET ENTITLED "THE LAKES AND GULF WATERWAY," WITH ILLUSTRATIONS AND NOTES, PUBLISHED BY THE CITIZENS' ASSOCIATION. PREPARED UNDER THE DIRECTION OF THE COMMITTEE ON MAIN DRAINAGE BY LYMAN E. COOLEY, CIVIL ENGINEER, CHICAGO, JAN., 1888.

The Deep Waterway Convention at Peoria in 1888 had submitted to it a brief entitled, "The Lakes and Gulf Waterway," by Mr. Lyman E. Cooley. Subsequently the Citizens Association had printed the report submitted by Mr. Cooley and added thereto a summary statement. and the entire pamphlet was distributed among the members of Congress for the purpose of securing the co-operation of the Federal Government in the construction of a deep waterway from Lake Michigan to the Mississippi River, using the proposed Sanitary District channel as a part of that waterway. This effort on the part of the Citizens Association of Chicago was referred to by Captain W. L. Marshall in his report of 1891, Chief of Engineers Reports, United States Army, page 2613. The following extract is taken from

the summary statement by the Citizens Committee:

"A channel of this capacity, if designed for sewage purposes alone, can be constructed at a less cost than if also suited to navigation. Uniting the two purposes in the same channel makes a navigable waterway a certainty, in the near future, while a channel for navigation alone, on account of its great expense, would most likely be delayed many years. It is proposed that Chicago shall pay the full cost of taking care of her sewage, leaving to the United States only the expense of suiting the channel to the purposes of navigation and improving the river below -in other words, while Chicago will, at her own expense, restore the ancient channel connection between the lakes and the rivers, the United States is simply asked to utilize the great waterway thus created for the purposes of commerce and national defense. The work of digging the channel between Joliet and Chicago (mostly through rock) and the construction of locks and dams at and below Joliet should proceed simultaneously, because the stone taken out of the cut may be used for the construction of these locks and dams, thus saving a large expense. What is asked of Congress at the present is a survey, location, plans and estimates, with a view to such co-operation.

All that is asked of the Legislature of Illinois is suitable legislation to enable Chicago to do its part of the

work, at its own expense."

Page 1146.

EXTRACTS FROM THE ACT OF MARCH 3, 1899.

Pages 1146 and 1156, Vol. 30 U. S. Statutes at Large. Improving the Illinois River, Illinois: Continuing improve-

ment, one hundred thousand dollars.

Illinois River and DesPlaines River, Illinois: The Secretary of War is directed to appoint a board of three engineers, which board shall make a survey and estimates of cost for the improvement of the upper Illinois River and Lower DesPlaines River, in Illinois, with a view to the extension of navigation from the Illinois River to Lake Michigan at or near Chicago; said board of engineers shall report the estimates of cost for a channel seven feet deep, and also for a channel eight feet deep throughout said proposed route; said survey and estimates of cost shall be made in pursuance and according to the recommendations in report of January twenty-seventh, eighteen hundred and ninety-seven, and there is hereby appropriated for the expense of said board and such survey the sum of thirty thousand dollars or so much thereof as may be necessary.

Page 1156.

Improving the Chicago River, in Illinois: Survey and estimates of cost for a channel twenty-one feet deep from its mouth to the stock yards on the South Branch, and to Belmont Avenue on the North Branch, so far as may be permitted by existing docks and wharves, exclusive of the cost of removing or constructing bridges or piers or lowering tunnels; and the aforesaid depth of twenty-one feet is hereby adopted as the project depth for the improvement in lieu of that fixed by the Act of June third, eighteen hundred and ninety-six: Provided, That all the work of removing and reconstructing bridges and piers and lowering tunnels necessary to permit a practicable channel with said depth to be obtained shall be done, or caused to be done, by the City of Chicago, without expense to the United States.

MEMORIAL.

PRESENTED BY THE TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO, FAVORING THE CONSTRUCTION BY THE GOVERNMENT OF THE UNITED STATES OF A DEEP WATERWAY FROM LAKE MICHIGAN, VIA THE CHICAGO SANITARY AND SHIP CANAL AND THE DES PLAINES AND ILLINOIS RIVERS, TO THE MISSISSIPPI RIVER. FEBRUARY 26, 1900.

I.—INTRODUCTORY.

To the Congress of the United States:

Your memorialist-William Boldenweck, Joseph C. Braden, Zina R. Carter, Bernard A. Eckhart, Alexander J. Jones, Thomas Kelly, James P. Mallette, Thomas A. Smyth and Frank Wenter—respectfully state that they constitute the present Board of Trustees of the Sanitary District of Chicago, and that, as such Trustees, they feel warranted in speaking for and on behalf of the population of said District, numbering about 1.800,000 people. They firmly believe they voice the sentiment of this population, with which sentiment they themselves are in entire accord, in saying that practically all the residents of the said District heartily favor the construction by the Federal Government of a deep waterway from Lake Michigan, via the Chicago Sanitary and Ship Canal and the Des Plaines and Illinois Rivers, to the Mississippi River. Since the opening of the said Sanitary and Ship Canal-January 17, 1900-a current of water from Lake Michigan approximating in volume 300,000 cubic feet per minute, and capable of floating vessels having a draught of twenty feet or less, has been flowing along the route of the proposed waterway, and the said Sanitary and Ship Canal was built without any expense whatever to the Federal Government.

Your memorialists respectfully represent that for more than half a century it has been the hope and desire of the people of the Middle and Northwestern States, and of the entire Mississippi Valley, that a deep waterway would be constructed at the earliest practicable date by the Federal Government, connecting the Great Lakes and the Gulf. Especially is this true of all persons residing in the territory mentioned who are interested in agriculture, commerce and manufacture. The existence of such a waterway would be a powerful factor in the natter of equalizing rates charged by other lines of transportation. Nor is the fact unworthy of consideration that the proposed waterway would afford an independent outlet to the sea, and would make it possible, in a time of emergency, for

the Government of the United States to send its light draught warships to the northern lakes without delay and without the possibility of having their passage blockaded or interrupted by any foreign foe. While it is not expected that the Federal Government would commit itself to the effort to secure a uniform depth of twenty feet of water from Chicago to the Mississippi River, it is believed, and the opinions of competent engineers show, that it is practicable to construct and maintain a waterway which would have a minimum depth of at least

fourteen feet at the lowest point.

It is the purpose of your memorialist, speaking now for themselves, only, to co-operate earnestly and heartily with all associations or organizations now existing or that may hereafter be formed, with a view to carrying this great enterprise to a successful conclusion. To that end the aid of the Congress of the United States is respectfully and urgently invoked, for we realize that without favorable Congressional action nothing can be done. It affords us much gratification to be able to state that the item of cost, which is nearly always the chief factor to be considered in such undertakings. is happily, in the present instance, reduced to a place of minor consideration. The most difficult problem in connection with this enterprise has already been solved. According to estimates made by the most competent and reliable engineers, considerably more than one-half of the total expenditure required to assure its success has already been paid, or assumed, by the Sanitary District of Chicago. The property owners of said District have submitted to an assessment of millions, and tens of millions, in the way of taxation for the construction of a Sanitary and Ship Canal, which, including six miles of the Chicago River, extends to Lockport, a distance of a little more than thirty-four miles from Lake Michigan. Full particulars of the cost and construction of this canal are set out hereafter. It is sufficient to say here that the profound conviction that the canal would certainly be utilized by the Federal Government as a part of the deep waterway which is to connect the Great Lakes and the Gulf of Mexico, induced the taxpayers to submit to these enormous levies with much more grace than they would have exhibited under other circumstances.

Your memorialists further respectfully represent that they have made a complete investigation as to the feasibility of the proposed undertaking, the difficulties which must be met and overcome, the natural conditions favoring such a waterway together with what is believed to be an approximately correct

estimate of the cost necessary to carry on the work beyond the present terminus of the Sanitary and Ship Canal. They have also prepared data showing that all the States in the Union are deeply interested in this enterprise and that all the people will be benefited if it is undertaken and completed. Figures will also be submitted hereafter, showing the tonnage now passing through the Detroit River, the St. Mary's Falls Canal, the Erie Canal and the Welland Canal. In short, they have endeavored to make this memorial an elaborate compendium of information bearing on the subject in all its phases, and the attention of the Senators and Representatives is respectfully invited to a careful perusal of this document in the hope that it may assist; even in a small degree, to persuade them that it is their duty, as it should be their pleasure, to commit the Federal Government to the support of this great enterprise.

II.—The Chicago Sanitary and Ship Canal.

The project for a deep waterway to connect the northern lakes with the Mexican Gulf is far from being a new idea. On the contrary, as has been hereinbefore stated, it has been actively agitated by the people of the Northwest, of the Middle States and of the entire Mississippi Valley, for more than half a century. It has been the dream of explorers and navigators for nearly three hundred years. As long ago as August 1, 1674, Joliet, the great explorer, writing to his friend, Father Dablon, said concerning a possible outlet from the Great Lakes

to the Gulf:

"A very important advantage, and one which some, perhaps, will find it hard to credit, is that we could quite easily go to Florida in boats and by a very good navigation. There would be but one canal to make, by cutting only one-half a league of prairie, to pass from the Lake of Illinois (Lake Michigan) into the St. Louis River (the Des Plaines River). The route to be taken is this: The bark should be built on Lake Erie, which is near Lake Ontario. It could easily pass from Lake Erie to Lake Huron, from which it would enter the Lake of Illinois. At the extremity of this lake would be the cut or canal of which I have spoken to have a passage to the St. Louis River, which empties into the Mississippi. The bark having entered this river could easily sail to the Gulf of Mexico."

When Joliet landed in Illinois he anchored his boat in the body of water now called Lake Michigan at a point near Summit, which is about eleven miles beyond and west of the present shore line at Chicago. Only a small stretch, composed

mostly of glacial drift, at that time prevented the water of the lake from discharging into the Illinois River. But this stretch, by natural accretions and artificial filling-in for the purpose of "making land," had extended from one-half a league of prairie to a distance of about ten miles in a little more than two centuries.

It has been said that the Chicago Sanitary and Ship Canal is a reversal of natural conditions, because it diverts the water of Lake Michigan from its natural flow. This statement, though made recently, was doubtless made in ignorance and, at any rate, is not true. Those persons who have only a slight knowledge of geological history know that the building of the canal has merely renewed conditions as they existed not many The Canal is simply the restoration of an centuries ago. ancient outlet from the Lakes to the Mississippi River which existed for ages. The Great Lakes, with their connections, were once an arm of the sea. Some great upheaval left them in a depression, from which their overflow sought the ocean in two mighty rivers, one setting its current towards the east from Lake Ontario, and the other sweeping away to the south from Lake Michigan and finally mingling its waters with those of the Gulf.

Ancient Connection of Lake and River.

The geological developments during the construction of the Sanitary and Ship Canal demonstrated conclusively that its course follows the track of the ice packs at the end of the latest glacial period, and that this track became in turn the bed of a great river. The rocky ridge encompassing Lake Michigan on the west and the southwest, weakened by the incessant pounding of the ice, gave way at one point and a crevasse 200 feet in depth was made in the solid limestone. Through this opening the waters of the Lake poured for many centuries, forming the river before mentioned.

When the preliminary surveys for the Sanitary and Ship Canal were made it was found that the trough or bed which had been ground in the rock by the action of the water was only six feet above the present lake level, and was about two miles wide and about twenty miles in length. It practically began at Summit, eleven miles from Lake Michigan, and extended to Lockport, twenty miles to the southwest. In the bed of this natural outlet the Sanitary and Ship Canal was con-

structed.

Reference has heretofore been made to the fact that the section now covered by the Sanitary and Ship Canal was long

regarded as an almost insuperable objection to the proposed waterway which was to connect the Lakes and the Gulf. The tremendous cost of constructing the channel through this section was always urged as a fatal obstacle to the success of the greater project. But this objection is no longer of any force. As has been before said, this weightiest and most perplexing problem of the entire scheme has been solved. The Sanitary District of Chicago has constructed a channel through this section capable of accommodating the largest sea-going craft that will ever come up the Mississippi River as far as St. Louis, even after the improvements in the Mississippi now under way, or that may hereafter be undertaken, have been completed. The completion of this section likewise removes the project from the inhibition of the Federal Government. whose policy, while favorable to improving rivers, harbors and canals by dredging, has been averse to cutting new channels through stone. Beyond Lockport, or the terminus of the Sanitary and Ship Canal, the only stone cutting to be done is that necessary to connect the extension channel with the Sanitary

and Ship Canal.

The construction of the Sanitary and Ship Canal was authorized by an act of the General Assembly of the State of Illinois, approved May 29, 1889. Under that act the Sanitary District of Chicago was organized. Its boundaries include all that part of the City of Chicago lying north of 87th street, and forty-three square miles of territory in Cook County outside the city limits. The District is eighteen miles long from north to south and about nine and one-half miles wide on a line passing through the court house in Chicago. Its extreme width is about fifteen miles. The district contains about 185 square miles and a population estimated at 1,800,000. The law establishing the District authorized the Trustees to levy and collect taxes for the construction of the canal and other improvements to the extent of one-half of one per cent. of the value of the taxable property within its corporate limits. Afterwards, by other acts of the Legislature, this power of levying taxes was increased to one and one-half per cent. for a period of five years, beginning with the year 1895. The Trustees were also empowered to issue bonds to the extent of five per cent. of the value of the taxable property of the District, as determined by the assessment for state and county taxes. It was, however, provided that the bonded indebtedness of the District should never exceed the sum of fifteen million dollars. Under this authority the District has issued \$14,990,000 of bonds, most of them being payable in from one to twenty years. Of these bonds \$3,630,000 have been retired, leaving \$11,360,000 outstanding.

Organization of the Sanitary District.

The first election of Trustees was held December 12, 1889. John J. Altpeter, Arnold P. Gilmore, Richard Prendergast, William H. Russell, Frank Wenter, Christoph Holtz, John A. King, Murry Nelson and Henry J. Willing were the successful candidates and constituted the first Board. Owing to dissensions among the Trustees, which made their appearance soon after the organization, the beginning of actual work on the Canal was delayed nearly two years. Trustees Nelson, King and Willing resigned in 1891, and at the November election of that year William Boldenweck, Bernard A. Eckhart and Lyman E. Cooley were chosen to fill the vacancies thus created. Trustee Holtz tendered his resignation January 16, 1892, and, it having in the meantime been accepted, Thomas Kelly was elected as his successor on the eighth day of the following November. However, the accession of Trustees Boldenweck, Eckhart and Cooley in the preceding year had operated to secure a harmonious majority in the Board, and the preliminary work of making surveys, securing rights of way and letting contracts was being aggressively pushed.

Ground was broken for the work of excavation September 3, The first shovelful of earth was thrown by Trustee Wenter, then President of the Board. From that time the work was pushed at every point, and though appalling obstacles were encountered now and then, and occasional interruptions were inevitable, the actual progress of the gigantic undertaking was not at any time seriously impeded. In a little more than seven years from the time the excavation was begun, the Sauitary and Ship Canal was so far completed that it was ready for use. The water was first turned into the channel January 2, 1900, and on the 17th of that month, the channel in the meantime having filled, the great Bear Trap Dam. constituting a part of the Controlling Works at Lockport, was lowered, and the water from Lake Michigan, after an interval of several centuries, once more resumed its flow toward the Gulf. While the required flow at present is limited to 360,000 cubic feet per minute, the channel is capable of carrying nearly twice that amount, and it is practically assured that within five years from this time arrangements will have been perfected to secure the maximum flow of 600,000 cubic feet per

ninute.

At the election held November 5, 1895, Trustees Wenter,

Boldenweck, Eckhart and Kelly were re-elected. Trustees Joseph C. Braden, Zina R. Carter, Alexander J. Jones, James P. Mallette and Thomas A. Smyth were at the same time elected to succeed Altpeter, Gilmore, Prendergast, Russell and

Cooley, whose terms expired December 2, 1895.

The first President of the Board was Murry Nelson, who served from February 1, 1890, to December 2 of that year. His successor was Richard Prendergast, who held the office about one year. Frank Wenter was elected to succeed Prendergast December 8, 1891, serving as President continuously from that date to December 3, 1895, a period of four years. Bernard A. Eckhart was elected to the Presidency of the Board December 3, 1895, and held the office until December 8th of the following year. He was succeeded by Thomas Kelly, who presided over the deliberations of the Board from December 8th, 1896, to December 7th, 1897. William Boldenweck, who was elected to succeed Mr. Kelly, has been twice reelected, and is now serving his third term as President of the Board.

Improvement of the Chicago River.

Before speaking of the Sanitary and Ship Canal proper, it may be well to describe the work which has been done by the Sanitary District in the Chicago River, which consisted chiefly of dredging from the Lake to Robey Street (at which point the river intersects with the Canal) to a uniform depth, except over tunnels, of twenty feet below the flow line. The District has also constructed a covered conduit, or by-pass, which extends from Monroe to Van Buren Streets. This by-pass accommodates a flow of water fifty feet wide and sixteen feet deep. Likewise two center pier bridges have been removedone at Taylor Street and the other the railroad bridge just south of it—and in their places have been constructed bascule bridges of the rolling hit type. A bascule bridge will also be substituted for the "jack-knife" bridge at Canal Street. At sundry places the river has been or is being widened and redocked. The last-named work is properly in the hands of the Federal Government, and the result of all these improvements has been to make adequate provision for a flow of 360,000 cubic feet of water per minute.

Negotiations are now under way, which your memorialists believe will be successful at an early date, for the lowering of the tunnels and the substitution of bascule bridges for all re-

maining bridges having center piers.

The Sanitary and Ship Canal begins at the junction of Robey

Street with the West Fork of the South Branch of the Chicago River, and extends to Lockport, which is 28.05 miles distant in a southwesterly direction. As the improved portion of the river from its mouth to Robey Street, a distance of six miles, may fairly be considered a part of the Sanitary and Ship Canal, its total length is therefore about 34 miles.

The dimensions of the channel are as follows: From Robey Street to Summit, a distance of nearly eight miles, it is 110 feet wide at the bottom and 198 feet at the water line, with a minimum depth of twenty-two feet. From Summit to Willow Springs, the distance being a little more than five miles, the channel is 202 feet wide at the bottom and 290 feet wide at the water line, with twenty-two feet depth. These are earth sections. At Willow Springs the Canal narrows to the walled and rock sections, extending about fifteen miles to Lockport, and is 160 feet wide at the bottom and 162 at the top. cross-section of the channel just above the Controlling Works. which is cut in stone, is enlarged for the purpose of forming a "windage basin," in which large vessels may be turned around. This enlargement was also made in order that the extension of the Canal could go on from the terminus of the channel without interfering with the Controlling Works. The grade in the earth sections is one foot in forty thousand feet. or one and five-eighths inches per mile; in the rock sections it is one foot in twenty thousand, or three and one-fourth inches per mile. It is intended to make the width of the channel uniform throughout the earth sections, 202 feet at the bottom and 290 feet at the water line, with a minimum depth of twenty-two feet from one end of the Canal to the other. The bottom of the channel at Robey street is 24.448 feet below Chicago datum, which is the same as low water in Lake Michigan at Chicago.

Construction of Sanitary and Ship Canal.

The total amount of excavation included 28,500,000 cubic yards of glacial drift and 12,910,000 cubic yards of solid rock, or an aggregate of 41,410,000 cubic yards. One of the most interesting features of the work of construction was the diversion of the Des Plaines River. As the plans provided that the channel should follow the bed of this river, it became necessary to excavate a new channel for the Des Plaines about thirteen miles in length. The new channel parallels the main channel throughout the distance mentioned, but about nineteen miles of levee had to be built in order to divorce the water of the Des Plaines watershed from the Sanitary and Ship Canal.

The width of the Diversion Channel at the bottom is 200 feet. At the head of the Diversion it became necessary to provide a safety-valve in the form of a spill-way to allow surplus water to flow toward Chicago. However, this spill-way will be dispensed with when arrangements have been perfected for carrying the entire flood-waters of the Desplaines through Joliet. The material excavated from the River Diversion included 1,810,000 cubic yards of glacial drift and 258,659 cubic yards of solid rock, making a total of 2,068,659. Adding this to the excavation from the Main Channel, gives a grand total of 43,478,659 cubic yards of material which was excavated. The whole volume of spoil (earth and rock), if deposited in Lake Michigan in forty feet of water, would make an island one mile square, with its surface twelve feet above the water line.

The Controlling Works at Lockport comprise seven sluice gates of metal with masonry bulkheads and one Bear Trap Dam. The sluice gates have a vertical play of twenty feet and openings of thirty feet each. The Bear Trap Dam has an opening of 160 feet and an oscillation of seventeen feet vertically. The Controlling Works are operated by admitting water through conduits controlled by a valve. Several tests have been made both of the sluice gates and the Bear Trap Dam, since the Canal was opened, and in each instance they have worked satisfactorily. Indeed, it is no exaggeration to say that the Bear Trap Dam is the greatest triumph of engineering genius that has ever been achieved in this or any other country.

All the bridges across the Sanitary and Ship Canal are movable structures. There are six bridges for public highways, one having double roadways. There are seven railway bridges, one being an eight-track rolling lift structure with a channel span of 120 feet. One is a four-track swing bridge, and the others are double-track structures. These bridges are of the very latest designs, and the entire weight of the iron and steel used in their constructions was 22,678,000 pounds. Every bridge is capitalized in a sufficient amount to provide for necessary repairs besides creating a fund to replace the structure when it has become no longer safe or useful.

Chicago's Contribution to the Waterway.

The total cost of construction, including interest account, aggregated \$34,000,000, January 1, 1900. Of this vast sum \$21,379,675.36 was expended in the work of excavation alone.

The cost of securing rights of way was more than \$3,000,000, and the expense for building railroad and highway bridges

and capitalizing the same exceeded \$4,000,000.

One of the most remarkable developments in connection with this work was the great improvement made in excavating machinery. In this connection, it may be well to quote a statement made by ex-Senator Warner Miller, of New York, who, after reviewing the work in progress on the Chicago Sanitary and Ship Canal, said, "That the use of the improved excavating machinery on the Isthmian Canal would undoubtedly reduce the cost of construction from 30 to 40 per cent." A description of some of the devices which were invented and built expressly for use on the Sanitary and Ship Canal would undoubtedly be very interesting, but the limits of this memorial will not permit further detail.

Finally, it is no exaggeration to say that the Chicago Sanitary and Ship Canal is one of the greatest artificial waterways ever constructed. Other canals may have cost more money and they may exceed this in depth, but this Canal has a greater cross-section than any other. It is safe to say that none presented half the difficulties which were encountered and overcome in this undertaking. The national value of the Canal will, of course, depend largely on the action taken by

Congress.

Section 24 of the Act of the Illinois General Assembly creating the Sanitary District of Chicago and authorizing the

construction of the Canal is as follows:

"When such Channel shall be completed and the water turned therein to the amount of 300,000 cubic feet per minute—the same is hereby declared a navigable stream, and whenever the General Government shall improve the Desplaines and Illinois Rivers for navigation to connect with this Channel, said General Government shall have full control over the same for navigation purposes, but not to interfere with its control for sanitary and drainage purposes."

It is the earnest desire of your memorialists that the Congress of the United States will, without delay, provide for the improvement of the Desplaines and Illinois Rivers to the extent set out in the section of the Illinois act just quoted, in order that the time may not be far distant when it shall become the great pleasure, as it will be the agreeable duty, of your memoralists to surrender such control of the Chicago Sanitary and Ship Canal to the General Government as will

permit it to be utilized as a part of the great navigable waterway which will connect the Northern Lakes and the Gulf of Mexico.

III.—Conditions of the Illinois Valley from Lockport to the Mississippi River at Grapton.

From Lake Michigan at Chicago to St. Louis the distance is three hundred and sixty-five miles. Of this distance thirty-four miles is traversed by the Chicago Sanitary and Ship Canal and forty-two miles by the Mississippi River. From the end of the Sanitary and Ship Canal at Lockport to the mouth of the Illinois River is two hundred and eighty-nine miles. Of this distance nineteen and one-half miles is covered by the Desplaines River, which joins the Kankakee to form the Illinois. For purposes of description and estimate the total distance is divided into three characteristic sections, namely: The Joliet section, from the end of the Sanitary and Ship Canal to Lake Joliet, eight miles; the upper Illinois, from Lake Joliet to Utica, fifty-four miles, and the lower Illinois, from Utica to the mouth, two hundred and twenty-seven miles.

The Joliet section is quite a regular declivity over Niagara limestone (the same formation through which the Sanitary and Ship Canal was cut) through the city of Joliet, with an elevation of twelve to fifteen feet below Lake Michigan at the end of the Sanitary and Ship Canal and descending to seventy-six feet below the Lake at the pool known as Lake Joliet. There is little soil over the rock along these eight miles and the Desplaines River has formed only a shallow channel in the rock. The pools formed for the Illinois and Michigan Canal and those created for water power were made chiefly by retaining walls and embankments. In geological history this slope was a great rapids in the ancient outlet of the lakes, and the pool known as Lake Joliet was formed in the softer rock at the foot of the rapids.

From the construction standpoint this stretch is the most expensive. Any waterway through this section must have ample prism to care for the flood waters of the Desplaines, as well as the flow of the Sanitary and Ship Canal, and it will normally be constructed partly by excavation and partly by walls and embankments. It has been considered that this amply prism could be best constructed by giving it a depth equal to that of the Sanitary and Ship Canal.

Several plans for treating the Joliet section have been studied for purposes of estimate, and it is believed that a project in harmony with the Sanitary and Ship Canal can be carried out for about eight million dollars. The pool known as Lake Joliet is five miles long and has ample depth when cleared of deposits. The project outlined contemplates an extension of the Sanitary and Ship Canal, and a part of the right of way needed has already been acquired, and all obstructions except one dam and water power and the old Illinois and Michigan Canal have been removed.

Conditions Favorable from Joliet to Utica.

From Lake Joliet to Utica the distance is fifty-four miles. with a descent from seventy-six feet below Lake Michigan to one hundred and forty-two feet below. The river bed is deeply cut and is divided into pools and rapids, according to the nature of the resisting strata. Lake Joliet, already mentioned, Lake Du Page, above the mouth of the Kankakee, and the pool above Marseilles cover over one-third the total distance. The average width of the river is from five hundred to six hundred feet between banks. There are no artificial olstructions on the upper Illinois except the mill-dam at Marseilles. The tributary watershed varies from 6,400 square miles at the mouth of the Kankakee to 10,400 square miles at Utica, and gives rise to floods, which come in part during the season of navigation. Owing to the very considerable declivity, high velocities exist in localities, and this makes expedient a large and deep channel in the interest of navigation and without regard to the depth which may be utilized. The studies thus far made show that the upper Illinois can be treated on three levels or pools with a depth of fourteen feet by means of three dams or locks. This depth will require considerable dredging for a channel three hundred feet wide. though a part of this may be dispensed with, but at the expense of efficiency.

A proper treatment will not injure any great area of bottom lands. Six highway and three railway bridges will require alteration. Trial estimates for actual projects show that a depth of fourteen feet with locks designed for larger depths can be produced throughout the upper Illinois for ten

million dollars.

dred and twenty-seven miles from Utica to Grafton, with a declivity which depends largely on the stage of water in the The lower Illinois, or alluvial section, extends for two hunMississippi. From the low water surface of the pool formed by what is known as the Henry dam at Utica bridge to the low water line of the Mississippi River, the descent is but thirty-four feet. Natural low water at Utica is but thirty-one feet extreme or twenty-eight feet at ordinary low water, and for much of the year it is considerably less, owing to the longer periods of moderate stages in the Mississippi. This remarkable feature of low declivity is coupled with low banks, not averaging more than twelve or fourteen feet above low water, and extensive bottom lands, some seven hundred square miles, intersected by sloughs and marshes. These conditions make a stream of low velocity and occasion wide and deep overflows in the flood season.

The low water width is generally from six hundred to one thousand feet and the ruling depth on bars at extreme low water is from eighteen to thirty inches. Experience in dredging these bars has shown a reasonable permanence in the channel produced, but the extreme low water volume before the opening of the Chicago Sanitary and Ship Canal was insufficient for a depth greater than four to six feet. The river has been improved by four dams and locks, two built by the State at Henry and Copperas Creek and two by the United

States at La Grange and Kampsville.

These dams have been the subject of much protest by the adjacent land owners, who claim that they increase the liability of overflow by moderate rises in the river. It is also claimed that they raise the water plane, thereby provoking deposits in the beds of tributary streams as well as in the river itself. The deterioration of the pools seems to be well established and is naturally to be expected in a stream of the character of the Illinois River. In 1889 the General Assembly of Illinois passed an act making the removal of the dams at Henry and Copperas Creek mandatory before the opening of the Chicago Sanitary and Ship Canal. The Legislature at the same time requested the Federal Government not to complete the works then in progress at La Grange and Kampsville and to change its policy to one of channel deepening in connection with the water supply from Lake Michigan. This request was repeated by the General Assembly in 1897.

Illinois' Policy Favors Fourteen-Foot Channel.

The policy of the State of Illinois requires an open channel of not less than fourteen feet in depth and a width of three hundred feet, to be secured by dredging, and a water supply of 10,000 cubic feet per second from Lake Michigan. This would mean a volume sixteen times greater than that of natural low water at La Salle and eight times greater than at the mouth of the Illinois. Such a virile stream would better maintain the channel and such an improvement would make a better drain, so that an increased volume of flood water would be provided for. On the other hand, such increase of volume, without removing dams and deepening the channel, would

cause widespread injury to material interests.

Official measurements have been made of the volume of water passing in the river at different stages. The bankfull stage, twelve feet above low water, would indicate a flow of 18,000 to 22,000 cubic feet per second from Utica to Havana; 30,000 cubic feet at La Grange and 40,000 at Kamps-The quantities show the probable effect of adding 10,000 cubic feet at low water. It is estimated that with the addition of 10,000 cubic feet of water per second there would be a uniform depth of not less than seven feet on the natural bars throughout the lower Illinois, except near the mouth. An additional depth of seven feet, making a total of fourteen, would have to be secured by dredging. A dredging of the shoals for the most efficient results would materially lower the flow line. An estimate has been made for a navigable channel three hundred feet wide and fourteen feet deep, which calls for the removal of from sixty to seventy million yards of earth at a cost of \$7,000,000. The material to be removed is easily handled, and the recent improvements in dredging appliances would doubtless make the above figures cover the cost of removing one hundred million yards.

In making these estimates the scouring action of the augmented volume is not considered, and there are special con-

ditions which make this an important aid.

From the mouth of the Illinois to St. Louis, a distance of forty-two miles, no sufficient study has been made of the conditions to justify an estimate of the cost of improvement. This section forms the boundary line between the two States and is less directly subject to the policy of the State of Illinois. It may be fairly assumed, however, as practicable to obtain fourteen feet of water in the Mississippi River from Grafton to St. Louis throughout the year, except when obstructed by ice. Records kept at Morris, on the Upper Illinois River, show that the ice season lasts on the average from sixty to seventy days, as against one hundred and twenty to one hundred and forty days in the year on the lake routes

from Chicago to Buffalo. During the past twelve years there would have been no interruption to navigation on the river route for two-thirds of the winters, and the stream could probably have been kept open in winter during the other

years by the aid of ice boats.

Your memorialists respectfully call attention to the fact that in legislating for the Illinois and Mississippi Canal, better known as the Hennepin Canal, which provided for a channel from the Illinois River above Hennepin to the Mississippi River at Rock Island, the Congress failed to make any provision for that part of the route required to reach Lake Michigan, which is absolutely necessary to make that canal useful. It may be assumed, however, that it was the intention of the Congress to utilize the Chicago Sanitary and Ship Canal when completed, and to improve the Desplaines and Illinois Rivers from Lockport, the terminus of the Chicago Canal, to the entrance of the Hennepin Canal, nineteen miles below Utica. If this was not the case the construction of the Illinois and Mississippi Canal could hardly be justified. However, that canal is only seven feet deep and is designed to reach points on the Upper Mississippi.

The Illinois River is susceptible to a far more radical improvement just as the Lower Mississippi justifies a much greater depth than does the Upper Mississippi. It would, unquestionably, be a great mistake to dwarf the Illinois River to the capacity of the Hennepin Canal. The larger depths and greater widths of the Illinois will serve the Hennepin better in permitting barge navigation to and from its eastern ter-

minus.

Summary of Arguments Favoring Project.

In conclusion, we sum up as follows:

1. An available navigation of fourteen feet, with locks for fleets of barges, and so designed as to permit greater depths in the future, may be had between the present terminus of the Sanitary and Ship Canal at Lockport and the Mississippi River for \$25,000,000. The channel improvements include five locks and dams in conjunction with a water supply of 10,000 cubic feet per second from Lake Michigan, and it is not possible to produce such a waterway without this water supply.

2. This depth will undoubtedly provide such a prism in the upper Illinois as will reduce the flood velocity to tolerable limits. It is believed that such a depth on the lower Illinois will avoid increased damage by overflow and produce a current strong enough to maintain itself against obstructive deposits. Its superiority for navigation needs no statement. This depth was determined upon as the least to be considered when the Chicago Sanitary and Ship Canal was authorized, and has been formally expressed as the public policy

of the State of Illinois.

The first effect of turning in the water from Lake Mich. igan after removing the dams is to extend an available steamboat and barge navigation as far up the Illinois River as Utica, which is only sixty-two miles distant from lake navigation at Lockport. Before the opening of the Chicago Sanitary and Ship Canal, lake and river navigations, for practical purposes, were three hundred and twenty miles apart.

The plans made on which the foregoing estimates were based were to test the possibilities of the route and for purposes of calculation. They were not intended to determine a final design, but it is not assumed that a final design would lessen the estimate, although it might greatly improve its

scope and make the work more efficient.

5. A variety of plans for extending deep water from the mouth of the Illinois to St. Louis have suggested themselves, but no estimate has been made. It is considered practicable

to accomplish this improvement.

That portion of the work between the end of the Chicago Canal and a point nineteen miles below Utica, a distance of eighty-one miles, and covering all the structural and most expensive operations, is necessary to be done in order to form an outlet for the Hennepin Canal. This portion, in fact, practically covers all the work necessary to open the waterway as a whole, and subsequent work will simply be in the nature

of betterment.

7. Finally, a navigation of fourteen feet from Chicago to St. Louis is justified, without regard to any river connection at St. Louis, yet the fact will at once suggest itself that, as a connection with the Mississippi River, this depth can be carried through to the Gulf of Mexico and maintained for enough months in the year to justify the expenditure. With the maintenance of eight to nine feet minimum of depth in the Mississippi River beyond St. Louis by the Mississippi River Commission, a depth of fourteen feet ought to be had for eight to nine months. The proposition is in harmony with such a natural development of the Mississippi as is believed to be not only possible but in the highest degree desirable from every standpoint.

IV .- POLICY OF THE STATE OF ILLINOIS ALWAYS FAVORABLE TO THE GREAT WATERWAY-HISTORY OF THE ILLINOIS AND MICHI-GAN CANAL

From the time that Joliet suggested the feasibility of a deep water connection between the lakes and the Gulf, coming down through more than two hundred years, the suggestion has been generally approved by navigators, explorers, engineers, scientists and other public men. The only exception was Marquette, who professed to regard the proposition as impracticable. It has been said that Marquette was influenced by jealous promptings to take an opposite view of the project, but this assertion is, probably, untrue.

There were also many men versed in statesmanship who realized the beneficial effects, commercial and otherwise, which would inevitably follow the construction of the connecting link. From the time Illinois was admitted as a State into the American Union, and even during territorial days. the proposition for a navigable waterway from the lakes to the Mississippi River was ever foremost in the minds of her ablest statesmen and of her greatest political leaders. interest in the project was not confined to the State of Illinois. It attracted the attention of public-spirited citizens all over the country.

Thus we find that in 1817 Samuel A. Storrow, Judge Advocate of the United States Army, who made a three months' tour through the west, was attracted by the situation in the Chicago River, and in a letter to Major General Brown, dated December 1, in that year, he commented on the practicability

of a permanent waterway as follows:

"Before the Chicago River enters Lake Michigan its branches unite, the one proceeding from the north, the other from the southwest, where it takes its rise from the very fountain of the Plein (Desplaines), or Illinois, which flows in an opposite direction. The source of these two rivers illustrates the geographical phenomenon of a reservoir on the very summit of a dividing ridge. In the autumn they are both without any apparent fountain, but are formed within a mile and a half of each other by some imperceptible undulations of the prairies, which drain it and lead it in different directions. In the spring the space between the two is a single sheet of water, the common reservoir of both; in the center of which there is no current towards either of the opposite streams. This circumstance creates the singular fact of the insulation of all of the United States except Louisiana, making the circumnavigation of them practicable from the Gulf of St. Lawrence to that of Mexico, with the single hindrance of the Falls of Niagara. The situation of the Chicago and De Plein Rivers should not escape National attention. The ground between the two is without rocks and with little labor would admit of a permanent connection between the waters of the Illinois and Lake Michigan."

Missouri Metropolis Favored the Canal.

As the idea of a navigable waterway between Lake Michigan and the Mississippi River rolled through the minds of thinking men in the early part of the present century, it acquired increasing importance. It was not too much to hope for a passage for any vessel that traversed either the lake or river. St. Louis was then a considerable town, and the idea of an artificial channel which would discharge the waters of Lake Michigan into the Illinois and Mississippi Rivers was enthusiastically advocated by her editors, orators and other prominent citizens.

In 1816 the Ottawa, Chippewa and Pottawatomie Indians ceded to the United States a strip of land twenty miles in width from Chicago to Ottawa, embracing the valley of the Desplaines and Illinois Rivers. Two years later surveyors were sent out to locate the boundary lines of the proposed channels, one beginning ten miles north and the other ten miles south of Chicago. Commenting on this work, the Enquirer, a newspaper published in St. Louis, expressed the sentiments of the people of that city in regard to the proposed waterway

as follows:

"The communication between the Lake and the Illinois is a point which will fix the attention of the merchant and the statesman. They will see in it the gate which is to open the northern seas into the Valley of the Mississippi and which is to connect New York and New Orleans by a water line which the combined navies of the world cannot cut off. Never did the work of nature require so little aid from the hand of art to complete so great a design."

The few permanent settlers at the mouth of the Chicago River at the time St. Louis was agitating the construction of the proposed channel had no influence, and their interests were hardly taken into consideration. As late as 1836, the year in which work on the Illinois and Michigan Canal began, Chicago had a population of only 3,820. But the East never lost sight of the benefits it would derive from a water communication with the Valley of the Mississippi, and the National Government was repeatedly urged to develop it. Various efforts were made in Congress to secure an appropriation for this purpose, but the policy of the Federal Government at that time was hostile to the idea of taking money out of the general treasury to devote to internal improvements.

Repeated reference to the importance of a canal communication between Lake Michigan and the Illinois River in the many years of Congressional discussion and attempted legislation in the line of internal improvements was an acknowledgment of its National character. No link in the chain of interstate commerce was more important than this, since it was on the great highway from the manufacturing East to the agricultural West and South. The speeches in the National Legislature indicate the prevailing sentiment, but the following paragraph from an editorial which appeared in Niles' Register of August 6, 1814, published in Baltimore, shows an exuberance of feeling:

"By the Illinois River it is probable that Buffalo may be united with New Orleans by inland navigation through Lakes Erie, Huron and Michigan to the Illinois River, and down that river to the Mississippi. What a route! How stupendous the idea! How dwindles the importance of all the artificial canals of Europe compared with this wa-

ter communication!"

Cession of Illinois Valley Lands by Indians.

The first practical steps towards the construction of a canal between Lake Michigan and the Illinois River was the execution of the treaty before mentioned with certain Indian tribes by which a strip of land about twenty miles wide, extending through the Desplaines and Illinois valleys from Chicago to Ottawa, was ceded to the United States. This treaty was negotiated at St. Louis, August 24, 1816, by Ninian Edwards, Governor of Illinois Territory; William Clark, Governor of Missouri, and Colonel Auguste Chouteau, of St. Louis. Immediately following the execution of this treaty, John Holmes, a representative from the State of Massachusetts, introduced into the lower House of Congress, December 11, 1817, a resolution instructing the committee on so much of the President's message as related to roads and canals to inquire into the expediency of providing by law for

constructing a navigable canal to unite the waters of Lake Michigan with the Mississippi. The resolution was carried, but the committee made no report. In the House, on April 3, 1818, when the question of admitting the Territory of Illinois to statehood was under consideration, Mr. Pope, of Kentucky, offered an amendment, which was adopted, providing for the extension of the boundary of the State farther north. By that

amendment Illinois gained the City of Chicago.

Illinois became a State in 1818. At that time the facility of opening a canal between Lake Michigan and the Illinois river was acknowledged by every one who had visited the Daniel P. Cook, a son-in-law of Governor Edwards. was the second Representative of Illinois in Congress, serving from 1819 to 1827. He devoted himself to the interest of the proposed canal, and it was largely through his influence that the State Legislature, in 1821, caused a partial survey of the route to be made for the purpose of demonstrating the practicability of the undertaking. From that time the Senators and Representatives from Illinois in Congress worked with unceasing diligence to secure an appropriation for the construction of the Canal. Finally a bill was passed March 2, 1827, granting to the State 200,000 acres of the public lands, which were to be sold and the proceeds applied to the work of construction.

The Illinois and Michigan Canal was completed in 1848, but the project was never carried out as originally contemplated. It received considerable financial aid from the State and the agitation for its improvement began soon after its completion. About 1867 the Federal Government and the State of Illinois united in the work of improvement. Many alterations were made, the channel being deepened in places and extended to

Ottawa on the Illinois River.

When the people of Chicago began the agitation for a Sanitary Canal which was to become a part of a deep waterway extending from Lake Michigan to the Mississippi River, they had no difficulty in securing the active co-operation of the State administration and the members of the General Assembly. Indeed, the fact that it was proposed to construct a channel of sufficient depth and width to float the largest lake craft then sailing from Buffalo to Duluth, removed all possibility of opposition to the enterprise. In the Act creating the Sanitary District of Chicago the Legislature provided as follows:

Legislation Favoring a Ship Canal.

"Section 23. If any channel is constructed under the provisions hereof, by means of which any of the waters of Lake Michigan shall be caused to pass into the Desplaines or Illinois Rivers, such channel shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be a depth of not less than fourteer feet, and a current not exceeding three miles per hour, and if any portion of any such canal shall be cut through a territory with a rocky stratum where such rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than eighteen feet, such portion of said channel shall have double the flowing capacity above provided for, and a width of not less than one hundred and sixty feet at the bottom capable of producing a depth of not less than eighteen feet of water. If the population of the district draining into such channel shall at any time exceed 1,500,-000, such channel shall be made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cubic feet of water per minute for each 100,000 of the population of such district, at a current of not more than three miles per hour, and if at any time the General Government shall improve the Desplaines or Illinois Rivers so that the same shall be capable of receiving a flow of 600,000 cubic feet of water per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow above 300,000 cubic feet of water per minute from such channel may cause to private property, so as to save harmless the said district from all liability therefrom, then such Sanitary District shall within one year thereafter, enlarge the entire channel leading into said Desplaines or Illinois Rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet of water per minute, with a current of not more than three miles per hour, and such channel shall be, constructed upon such grade as to be capable of producing a depth of water not less than eighteen feet throughout said channel, and shall have a width of not less than one hundred and sixty feet at the bottom; in case a channel is constructed in the Desplaines River, as contemplated in this section, it shall be carried down the slope between Lockport and Joliet to the pool, commonly known as the upper basin, of sufficient width and depth to carry off the water the channel shall bring down from above. The district constructing a channel to carry water from Lake Michigan of any amount authorized by this act, may correct, modify and remove obstructions in the Desplaines and Illinois Rivers, whenever it shall be necessary so to do to prevent overflow or damage along said river, and shall remove the dams at Henry and Copperas Creek, in the Illinois River, before any water shall be turned into the said channel. And the Canal Commissioners, if they shall find at any time that an additional supply of water has been added to either of said rivers, by any drainage district or districts, to maintain a depth of not less than six feet from any dam owned by the State, to and into the first lock of the Illinois and Michigan Canal at La Salle, without the aid of any such dam, at low water, then it shall be the duty of said Canal Commissioners to cause This Act shall not such dam or dams to be removed. be construed to authorize the injury or destruction of existing water power rights.

Section 24. When such channel shall be completed, and the water turned therein to the amount of three hundred thousand cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the General Government shall improve the Desplaines and Illinois Rivers for navigation, to connect with this channel, said Government shall have full control over the same for navigation purposes, but not to interfere with

its control for sanitary or drainage purposes."

Illinois Asks General Government to Extend Canal.

Again, at the session of 1897, the Illinois General Assembly adopted a series of joint resolutions regarding the Chicago Sanitary and Ship Canal, and calling upon the Federal Government to extend the deep waterway thus begun to the mouth of the Illinois River. Only such portions of the preamble and resolutions as bear directly on the subject in hand are here given, as follows:

"Whereas, the construction of the Sanitary Canal of Chicago, and the large volume of water required to flow through the same, will bring lake and river navigation, which are now 320 miles apart, within 60 miles of each other, and the development of the intermediate section

between Lockport and Utica will furnish a through route from the Great Lakes to the Lower Mississippi by way of the Lower Illinois River, and the Upper Mississippi by way of the Hennepin Canal; and, further, that the proportion of three routes constructed by the Sanitary District of Chicago will exceed the cost of extending the largest useful navigation by way of the Illinois River to the Lower Mississippi, together with that of the Hennepin Canal, to the Upper Mississippi; and

Whereas, we believe the making of a deep waterway of the Illinois River to be an undertaking which is national in its character and should be accomplished by the General Government for the general welfare, the inland and maritime commerce of the nation, and for the na-

tion's defense in time of war; therefore, be it

Resolved by the Senate, the House of Representatives concurring therein:

1. That it is the policy of the State of Illinois to procure the construction of a waterway of the greatest practicable depth and usefulness for navigation from Lake Michigan by way of the Desplaines and Illinois Rivers to the Lower Mississippi River, and by way of the Hennepin Canal to the Upper Mississippi River, and to encourage the construction of useful feeders thereto.

3. That the rock-bound section of the Desplaines and Illinois Rivers form (from) the end of the Sanitary Canal of Chicago at Lockport to the head of the Alluvial River at Utica, should be developed for a navigable depth of not less than fourteen feet, and that the United States is requested to enter upon this work in co-operation with all lawful agencies provided for in this state and in harmony with the policy herein set forth."

The character of the Illinois and Mississippi Canal, better known as the Hennepin Canal, and its relations to the Chicago Sanitary and Ship Canal, have already been fully described

in Section III of this memorial.

V—NATIONAL CHARACTER OF THE PROPOSED DEEP WATERWAY— ITS IMPORTANCE FROM A COMMERCIAL AND NATIONAL STAND-POINT.

If the proposed waterway which is to connect the lakes with the Gulf is not National in character, then it follows as a matter of course the project is not worth the consideration of the American Congress. If the beneficial effects to follow its construction would be confined exclusively to the State of Illinois, it would then become a purely local enterprise and the state would go ahead and complete it in accordance with its own well established policy and in the spirit of modern progress.

But the fact that it is a National project was long ago understood and appreciated by such men as Albert Gallatin, of Pennsylvania; John Pope, of Kentucky; Peter B. Porter, of New York; Henry St. George Tucker, of Virginia; John C. Calhoun, of South Carolina; Jessie B. Thomas, of Illinois; Christopher Rankin, of Missouri; Henry Clary, of Kentucky,

and many others.

The people of the Sanitary District of Chicago realized that the sanitary canal would ultimately be utilized as a part of a great National enterprise. While they would not have hesitated to incur the expense necessary to provide a complete and perfect system of sanitation for the City of Chicago, they knew that the sanitary canal was not to be limited to the single purpose of drainage. They knew that for every dollar paid out for a sanitary canal, another dollar was expended to make the capacity of the channel sufficient to carry any ship that traversed the Great Lakes at the time the work was begun. For instance, the extraordinary expense required to make the bridges crossing the channel, movable structures, was about \$2,500,000. The tax payers understood that in order to have a navigable waterway the bridges must be of this character.

No one can study the situation and environments without coming to the conclusion that this project is national in character, and being so, the remainder of the work should be completed by the Federal Government. Under the law the Federal Government would have control of the entire waterway and would be solely responsible for exercising that control for purposes of navigation. Interest in the movement for deep waterway from Lake Michigan to the Gulf of Mexici intensifies in the presence of the overwhelming sentiment favorable to the construction of an Isthmian Canal, which is to

connect the Atlantic and Pacific Oceans. With the Isthmian Canal a reality, as it will undoubtedly be in a few years, it becomes evident that a navigable waterway crossing the center of the continent and connecting with the Great Lakes will become not merely a desirability, but an actual necessity. deep waterway from New Orleans to Chicago will traverse the greatest agricultural and industrial area on the globe, populated with the most moral as well as the most intelligent Where can another such area be found as that of the Mississippi Valley? A valley with the greatest variety of soil and climate, extending from the Allegheny to the Rocky Mountains, and limited on the north by the Canadian boundary and a chain of fresh water lakes. The great tributaries which go so far as to increase the fertility of this valley are the Ohio and Missouri Rivers, the one rising in the Northeast and the other in the Northwest, and both flowing obliquely to form a junction at the heart of the continent. This valley contains within its boundaries everything essential to constitute one of the greatest empires of history.

Effect on Trade With South America and the Orient.

Apart from the changed conditions which would surely result from the construction of the Isthmian Canal and the resultant stimulating effect a deep waterway from the Gulf to the Lakes would have on our Asiatic commerce, we may well consider the immense benefits to our steadily growing trade with South America, which would be caused by the building of the smaller waterway. From every lake port as far east as Detroit, and probably Cleveland, the prevailing disposition among the agricultural, manufacturing and mining interest would be to send their products destined for a South American port by way of Lake Huron, Lake Michigan, and thence by the Chicago Sanitary and Ship Canal and the Mississippi River to the Gulf of Mexico.

It would be impossible, even if it were advisable, to confine the beneficial effects of the proposed waterway to a single state. Possibly these effects might be more apparent in the Middle, Southern and Western States, but this is by no means certain. As the waterway would be a national enterprise, its blessings would naturally extend to every part of the Union. Albert Gallatin, who was Secretary of the Treasury during President Jefferson's administration took this broad view of the project when he said in a special report on roads and

canals, dated April 6, 1808:

"That good roads and canals will shorten distances,

facilitate commercial and personal intercourse and unite by a still more intimate community of interest the most remote quarters of the United States. No other single operation within the power of government can more effectually tend to strengthen and perpetuate that union which secures external independence, domestic peace and

internal liberty."

Referring to the desirability of a connection between Lake Michigan and the Mississippi River, he said that if navigation between the Western Rivers and the Lakes was opened, either from the Mississippi to Lake Michigan, or from the Northwest by Lake Superior, the whole Indian trade of those regions would necessarily center in an Atlantic port of the United States. He regarded the commercial phase of the subject as being of minor importance, however, when compared with other advantages of that great communication and the immense weight they would have in its relation to the political intercourse of the United States with the Indians. The estimate of the cost of the improvements necessary to reach the Mississippi River from the Lakes was \$20,000,000, and to raise that sum he suggested that the government sell 10,000,000 of its 100,000,000 acres of public lands. lieved the increase in the value of the remaining 90,000,000 acres would more than repay the outlay. His report was referred to the committee and a week later 1,200 copies were ordered printed.

Necessity for Waterway Grows With Time.

If in the time of President Jefferson, when the white population of this country constituted a mere fringe extending along the Atlantic Coast and around the Gulf Coast to New Orleans, the connection of the lakes with the Gulf by a navigable waterway was considered of paramount importance, it seems the proposition should require no advocate now, when the combined population of the states of Illinois, Indiana and Missouri alone is greater than that of all the states at the time Secretary Gallatin wrote the first report favorable to this project.

Your memorialists respectfully represent as further reason for the construction of the proposed waterway, that it will provide for competition in freight rates during the open season in navigation between the Northwestern and Middle Western States to the Gulf. It will also create from the Canadian line to the Gulf a through water route owned by the people and not by the corporations. It will provide ample

facilities for modern and popular barge transportation. It will afford the Great Lakes and their ports double connection with the Atlantic, east and south, and with the completion of the Isthmian Canal, will put them in closer touch with

our new possessions in the Pacific and the Orient.

It would be easy to extend this memorial indefinitely with the opinions of public men touching its feasibility and practicability. These are matters, however, which will suggest themselves to the Congress if it in its judgment sees proper to consider this project. In this connection, however, the following extract from the annual report of Mr. George F. Stone, Secretary of the Chicago Board of Trade, would seem

to be of great interest:

"With the growth of our country," Mr. Stone writes, "and a general development of transportation facilities in foreign lands, the project for a navigable connection between Lake Michigan, at Chicago, and the Mississippi River, via the Des Plaines and Illinois Valleys, assumes an importance in our domestice commerce comparable to that which the Suez Canal or the crossing of the American Isthmus will have in regard to the commerce affected by those great works. Its completion would result in a continuous navigable waterway from the Atlantic, via the St. Lawrence, through the lakes to Chicago, thence to the Mississippi, and thence to New Orleans. tary and commercial importance might be conclusively demonstrated. It is, I am aware, insisted upon that we have no need, in these peaceful and enlightened times, to keep in view the liability of war. Certainly, in this age, no permanently aggressive character should be given to our military facilities, but we are not justified in wholly neglecting them or ignoring a remote possibility of for-It has been an embarrassment, evieign complications. dent and inevitable to our diplomatic correspondence in momentous crises, that our means of defense have been inadequate, and that the country could not afford to be otherwise than cautiously pronounced in the assertion of her rights. The completion of this great national project would, besides conferring inestimable benefits upon commerce, enable the government to place her gunboats by way of the Mississippi upon the lakes for the protection of immense marine interests. Think you that the existence of such facilities as this waterway from the Gulf to the north Atlantic would create, would have no effect upon state discussions of grave issues, when treaty or other rights are threatened or violated? Means of defense are as valuable in times of peace as in war; they tend to prevent war by forcibly suggesting the concession By the completion of this waterway, the entire system of transportation upon the continent would be straightway affected in the interest of consumer and producer; the south and the north, the east and the west, The movement of cotwould feel its beneficent results. ton, grain, coal, timber, iron and merchandise of all kinds would be beyond the power of dictation by transportation monopolies, because countless salutary irresistible restraints would spring into life. It would be a section of an interstate commercial law which could never be repealed, and the authority of which could never be ques-It is national in its character, and appeals for its support to every citizen in the land. Its most enthusiastic advocates should not be found here, but in the south and in the east, where are consumed the products of the west, and which, in turn, wish cheap transportation for their manufactures to sections the yearly resources of which have not been absorbed by excessive freight rates."

Statistics of Traffic on Great Lakes.

Not until the eleventh census was taken were full statistics gathered of the movement of commodities upon the whole lake system, and since then the data collected has been far from In fact, the information is so meager, and in part so incomplete, that it is very difficult even to give the total movement on the Lakes. Nothing in reference to the subject can be obtained prior to the year 1889. However, many circumstances have recently directed attention to the transportation of facilities of the Great Lakes. The rapid growth of traffic, the increasing size of lake vessels, the celerity with which ships are loaded and unloaded, and other developments have interested a large number of people, while the vital significance of cheap carriage to the mining, farming and lumbering interests and their numerous dependent industries has compelled all persons engaged in these occupations to give careful consideration to the main question, and the whole subject of the inland waterway has been given public attention by appeals to Congress for large appropriations to improve existing harbors and channels and to construct a deep waterway from the Great Lakes to the Sea. Yet, in spite of this widespread desire for information about lake commerce and its far-reaching importance to many great national industries, the question has been almost neglected, not only by writers on transportation, but by the government as well; and this in the face of the fact that Congress is annually called upon to vote large sums of money to facilitate traffic upon these waters.

In former years the commerce passing through the Detroit River was practically equal to the total movement on the lakes, but in recent years business between Lake Superior and Lake Michigan ports has so greatly increased that the commerce through the Detroit River is not now so good an index of the whole movement on the lakes as formerly.

Statistics bearing on this phase of the matter have been derived from reports of chief engineers, mainly those of Colonel O. M. Poe. The following table covers the traffic passing up

and down the Detroit River during the years named:

Year.	Registered Tonnage.	Freight Tonnage.
1873		9,000,000
1880	20,235,249	
1881	17,572,240	
1882	17,872,182	
1883	17,695,174	
1884	18,045,949	
1885	16,777,828	
1886	18,968,065	
1887	18,864,250	
1888	19,000,000	
1889	19,646,000	19,717,860
1890	21,684,000	21,750,913
1891	22,160,500	23,209,619
1892	21,785,000	26,553,819
1893	,,	23,091,899
1894	26,120,000	24,263,868
1895	20,220,000	(25,845,679)
2000		29,000,000
1896		27,900,520

It is impossible to secure sufficient information on which to base even an estimate of the percentage of traffic from Lake Superior ports which does not go through the Detroit River into Lake Erie. It is known, however, to be considerable. It is probably true that the traffic from ports on Lakes Michigan and Huron is equal to that coming through the St. Mary's Falls Canal, but the figures showing the tonnage passing through the Detroit River do not indicate this to be a fact. There must be a considerable diversion of the traffic from the upper lake after it enters Lake Huron.

Increased Tonnage Passing Through St. Mary's Canal.

While the traffic statistics show satisfactory increase, considering the unreliability of the figures, the best evidence of an increased traffic on the Great Lakes is the growth of the The charts indicate that during the five years lake fleet. from 1868 to 1872, inclusive, the lake fleet did not quite maintain its own, but made rapid gains from 1872 to 1875, when the total tonnage stood at 587,234. Then the tonnage declined to 552,602 in 1879. During the ensuing four years there was a rapid increase, and then a moderate increase for one year until 1886 when the tonnage stood at 690,359. 1886 the tonnage has almost doubled, large accessions having been made every year except in 1894 and 1895. Improved facilities for fueling, loading and unloading vessels have also very greatly increased the carrying power of the whole fleet, to say nothing of the enlarged carrying power, due to better locks and the lighting of channels so as to permit passage by Taking into account all the improvements, other than night. the substitution of steam for sail, conservative estimates show that this power has increased from 742,286 in 1868 to 3,326, 502 in 1897.

The extraordinary growth of the tonnage passing through the St. Mary's Falls Canal is in striking contrast with the slow increase of that passing through the Detroit River. The registered tonnage going through the St. Mary's Falls Canal increased from 1,204,446, in 1873 to 17,619,933 in 1897. There was also an increase in freight tonnage from 1,567,741 in 1881

to 18,982,755 in 1897.

The latest reliable statistics attainable on the subject of lake shipping show that the amount of freight passing through the various canals in 1897 was as follows:

 St. Mary's Falls,
 18,982,755

 New York (Erie Canal),
 1,878,218

 Detroit River (1896),
 27,900,520

 Welland Canal (1896),
 1,279,987

It is conceded that a considerable percentage of the traffic passing through the St. Mary's Falls Canal does not pass out through the Detroit River, but comes direct to Chicago.

The Congress is respectfully requested to give earnest attention to the facts and arguments set out in this memorial. The fact that the project is an old one, and has engaged the attention of public men for almost a century should not be urged as an excuse for treating it lightly. It is a propo-

sition worthy of being judged upon its merits alone, and by them alone it should be permitted to stand or fall.

Your memorialists have the honor to subscribe themselves,

Yours respectfully,

WILLIAM BOLDENWECK, (Signed) JOSEPH C. BRADEN, ZINA R. CARTER, BERNARD A. ECKHART, ALEXANDER J. JONES. THOMAS KELLY, JAMES P. MALLETTE, Тномав А. Ѕмтн. FRANK WENTER,

Members of the Board of Trustees of the

Sanitary District of Chicago.

I, Joseph F. Haas, clerk of the Sanitary District of Chicago, and keeper of its records and seal do hereby certify that the above and foregoing memorial to the Congress of the United States was prepared under and by authority of a certain order adopted by the Board of Trustees of said District at a regular meeting held February 14, 1900; and I hereby certify that the following is a true and correct copy of said order that day adopted:

Ordered, That the joint committee on Federal Relations and Engineering are hereby authorized and directed to prepare a suitable memorial, to be presented to Congress, advocating the establishment of a deep waterway from the terminus of the Chicago Sanitary & Ship Canal at Lockport, Illinois.

through the Illinois Valley to the Mississippi.

Ordered, further that said committee be empowered to have said memorial printed in such number and at such times as in its discretion may be deemed advisable, and lay the same before Congress.

Witness my hand and the seal of the Sanitary District of

Chicago, this 26th day of February, A. D. 1900.

(Seal)

(Signed) JOSEPH F. HAAS, Clerk of the Sanitary District of Chicago. EXTRACT FROM A REPORT OF BREVET MAJOR GENERAL J. H. WILSON, UNITED STATES ARMY, LIEUTENANT COLONEL 35TH INFANTRY, ON THE SURVEY OF THE ILLINOIS RIVER FROM LA SALLE TO ITS MOUTH.

United States Engineer's Office,

Des Moines and Rock Island Rapids Improvement and Illinois and Rock River Surveys,

Davenport, Iowa, February 15, 1867.

General: Having been charged by instructions from the Engineer Department with "the survey of the Illinois River from La Salle to its mouth," provided for by Act of Congress, June 23, 1866, I have the honor to submit the following

report:

The act just specified simply provides for the survey as designated above, and gives no indication whatever of the object of the survey, or the kind of improvement which it is intended to illustrate. It was assumed, however, that, as the general government had originally provided for the improvement of the Illinois River by dredging its bars to a navigable depth, and had actually expended a considerable sum of money in operations of this sort, this act in question specially requires estimates for the completion of this plan. Under date of September 13, 1866, I received the following from

the Engineer Department:

"Minute instructions have not been given to you in relation to these surveys, since the intentions of Congress were not fully known to the department. Especially is this the case with the survey of the Illinois River, as no report from this department to Congress was made during the last session when the appropriation was made. The supposition is that the survey of this river has immediately in view its capacity for navigation to La Salle for the largest possible class of steamers that the river will admit when certain obstructions shall have been removed, and ultimately the determination of canal facilities with Lake Michigan, and the solution of the question of an adequate supply of water from Lake Michigan as a reservoir for the canal and river during periods of low water. The act of appropriation, however, only provides for the survey of the river from its mouth to La Salle, and to this your operations must be restricted." Subsequently, by letter from the Engineer Department,

dated January 8th, 1867, I was directed to continue the examination of the Illinois River as far towards its source as there may be reason to believe that it is susceptible of improvement for the purposes of commerce and navigation.

On the 16th of September I gave Mr. Abert the following instructions:

"The object of this survey is to obtain such specific and accurate information in regard to the obstructions to navigation in that river as will enable you to submit estimates for its improvement, so that the largest boats navigating the Illinois and Michigan Canal, and steam boats drawing four feet of water, will be enabled to pass through the river to St. Louis during the season of extreme low water without breaking cargo. To this end you will examine and carefully delineate the various features of the river at and in the vicinity of the difficult bars and shoals; projecting your maps of these localities on a scale sufficiently large to show the amount of excavation necessary in order that the water may be sufficiently deepened. You will observe, as far as may be practicable, the specific cause of the bars and shoals; the influence of islands and bends of the river; the width, depth, velocity and cross-section, with capacity of the back-channels chutes at the islands, and of the river itself at the locality of the obstructions; the width of the bottom lands; and, in general, will obtain every class of information likely to throw light upon the entire subject of improvement, whether by dredging, wing-dams, or other means.

The river having been already surveyed several times it may not be necessary to accurately triangulate it through its entire length, although it is desirable to have its fall from the initial point of the survey to its mouth accurately determined."

This plan of improvement, although it applies to a part of the river only, and cannot be depended upon to give more than four feet navigation under the most favorable circumstances, without a feeder from the lake, has many friends along the river. This is due, however, in many cases to the belief that any other plan will unfavorably affect the interests of some towns and localities, and unduly benefit others. But such considerations as these, whether well or ill-founded, are not of sufficient importance to exert a material influence in the

solution of the questions under discussion. There is no doubt that dredging alone, or, at most, dredging and a feeder from the lake, can be made to answer every purpose in the improvement of the Illinois River, if it is to be considered as independent navigation of no other than local importance; but it must be remembered that this river is not the exclusive property of those living upon its banks. It forms already an important link in a net work of river navigation extending, with it various branches, through 17 states of the Union, and is destined at no distant day to become the great commercial highway between the productive states of the West

and Northwest and the markets of the world.

The Illinois River seems to have been specially designed by nature as the line by which the waters of Lake Michigan are to be connected with those of the Mississippi. Its two principal tributaries, the DesPlaines and the Kankakee, rising the one in Wisconsin and the other in Indiana, run for many miles almost parallel with the western and southern lake shore, and are separated from the lake basin by a ridge of insignificant height and width. A moment's consideration will show that at no remote period the waters of the lake must have been carried off by these streams as well as by the St. Lawrence. It has been already shown that the highest point of this ridge on the line of the Illinois and Michigan Canal is only 14 feet above the ordinary level of the water in the Chicago River at Bridgeport, and it is by no means certain that a lower line may not be found by a careful survey. In fact, it is the opinion of many old contractors who are well acquainted with the entire region, that a much more favorable location for a steamboat canal can be obtained from Bridgeport to Section 46 of the present canal, by following the line through Mud Lake. But let this result be as it may, the data herein contained, together with the existence of a canal of limited capacity already in operation, demonstrate beyond a doubt that the waters of the lake may be carried into the Illinois River through a navigable channel of any required dimensions, and at a cost which cannot be regarded as excessive when the objects to be obtained are duly considered.

As all the lockage will be descending from the lake, it is apparent that the only limit to the capacity of the canal will be that which depends upon the velocity with which the locks can be filled and emptied. The summit will be inexhaustible, and this cannot be said of any other practicable line of water communication between Lake Michigan and the Mississipi.

MACOMB REPORT OF 1875.

EXTRACT FROM A REPORT ENTITLED "SECOND SUBDIVISION OF THE NORTHERN TRANSPORTATION ROUTE—HENNEPIN CANAL," THE SAME BEING PART OF A REPORT UPON "TRANSPORTATION ROUTES TO THE SEABOARD." Page 94.

REPORT OF COLONEL J. N. MACOMB, CORPS OF ENGINEERS.

ROCK ISLAND, ILL., January 25, 1875.

General: I have the honor to present herewith the report of Mr. F. C. Doran, assistant engineer, who was charged by me with the duty of making the surveys and estimates for the Hennepin Canal Route, and particularly for the extension to Chicago.

In considering the Hennepin Canal as a part of the water-communication desired for connecting some point of the Mississippi River near Rock Island, with Lake Michigan, at Chicago, it appears that the basin at Hennepin is about 100 feet below the level of the Mississippi River in the vicinity of Rock Island, and nearly 140 feet below the level of Lake Michigan.

A survey was made to ascertain if the lockage required to pass this depression of the Hennepin Basin could be avoided. This survey led to the conclusion that, on every account, the Hennepin Canal and Upper Illinois River, and enlarged canal from Joliet to Chicago, will afford the best through route for navigation between the Mississippi River and Lake Michigan that can be secured in this vicinity.

The most important and costly part of the route across this section of the country is the portion between Hennepin and Chicago; for this part is essential as affording an eastern outlet for the Hennepin Canal traffic, and for perfecting the navigation to Chicago from the Lower Mississippi River through the Illinois River, which is now being improved for steamboat navigation from the Hennepin Basin down to the Mississippi River. Indeed, the Hennepin Canal, without the improvement of the Upper Illinois River and the enlargement of the eastern portion of the Illinois and Michigan Canal, would be useless as an outlet for the freights of the Upper Mississippi River; and a careful consideration of the subject has shown that the improvement of the Upper Illinois River to accord with the scheme of improvement now in progress

for its lower portion, is greatly to be preferred as a measure of economy in its broadest sense, rather than to undertake the enlarging of the western portion of the Illinois and Michigan Canal lying between Joliet and the Hennepin Basin.

The improvement of the eastern portion of the Illinois and Michigan Canal involves the further cutting down of the summit level and enlarging the waterway so as to afford an unfailing supply of water from Lake Michigan for the

improved Illinois River.

It will be seen by the report of the assistant engineer that the estimate for the route, as above sketched out, for a navigable waterway from the Mississippi River, near Rock Island, to Chicago, on Lake Michigan is.....\$19,780,535 To which should be added the amount of in-

crease in estimate for locks of proper size on

641,284

Making a grand total of\$20,421,819 All of which is respectfully submitted by your most obedient servant. J. N. MACOMB,

Colonel of Engineers, U.S.A.

Brig. Gen. A. A. Humphreys, Chief of Engineers, U. S. A.

REPORT OF MR. F. C. DORAN, ASSISTANT ENGINEER.

ROCK ISLAND, ILL., January 9, 1875.

Page 96. Colonel: I have the honor to submit the following report upon the examination and survey of a route for a canal between Lake Michigan and the Mississippi River, together with the survey of a portion of the Illinois River. This survey having been committed to me, in obedience to your instructions bearing date Rock Island, Ill., July 9, 1874, I proceeded to organize and equip a party for field-service. The whole time employed by the party in field-operations was 83 days. Of this time, five weeks, or a little more than one month, were spent in examinations and surveys of a direct line joining the lake and the Mississippi; the remaining six weeks were devoted to the survey of the Illinois and Michigan Canal and a part of the Illinois River. These surveys have traversed quite a large expanse of country, having, within the time specified, examined and surveyed lines to the extent of Two Hundred and twenty-five miles.

As will be seen, this report is intended to embrace a statement of facts in relation to the Illinois and Michigan Canal and Illinois River as they at present exist, with a description of the several improvements and enlargements proposed, together with a detailed tabular statement showing the estimated cost of the improvement throughout the entire line, ex-

tending from the lake to the Mississippi.

I would preface with a condensed statement of the results of my examination of the direct route first mentioned. One of the principal objects to be attained by the survey was to obtain data and accurate notes of the topography of the country lying between Lake Michigan on the east and the great bend of the Mississippi on the west, and from the information obtained, to determine as to the practicability of a plan for a water-route to connect the lake and the river at the points specified.

The survey of the Illinois and Michigan Canal and the Des Plaines and Illinois Rivers was commenced October 5, at the old lock in the canal at Chicago, and was continued along the canal and river to where the canal unites with the river at La Salle, suspending field-work at this point, November 10, The entire distance, as measured along the canal and river, is 99.28 miles. Of this distance 36.53 miles is canal and 62.75 miles river-line; 32.65 miles of the former lie between Chicago and Joliet; the first 29.55 miles of this constituting the summit-level of the canal. The lockage on this route is all descending from the lake, and amounts to an aggregate of 145.6 feet, as determined by our levels.

In order to carry out your instructions, a thorough reconnaissance was made of the country, extending from the lake to a point, in the present line of canal, some 18 miles out from the lake, known as Sag Ridge, including the Calumet Feeder route. But as these examinations failed to discover any route possessing as favorable features as the existing line of canal presented, and as this canal had been originally located with great care, it was determined to adhere to the present align-

ment.

The original proposition in regard to the enlargement of this work, to dimensions corresponding to those adopted on the Lower Illinois River improvement, has been kept in view, and all quantities and the cost of the entire work have been calculated in accordance therewith. The dimensions there adopted, as you are aware, are as follows, viz., lockchamber, 350 by 75 feet. A restriction to these dimensions is rendered necessary in order to produce a complete and homongeneous system of navigation between the take and

the great rivers of the west.

It is believed that the proposed plan of enlargement of the Illinois and Michigan Canal, combined with the improvement of the river and the construction of the Hennepin Canal, will, when completed, meet the wants of the commercial world, affording as well facilities for the passage of war vessels from the rivers to the lakes, or vice versa.

The plan of locks adopted, although identical in size of chamber with those constructed on the lower part of the Illionis River, would differ somewhat in detail of construc-

tion and in the material employed in the gates.

The general features of the country along the line of canal and river are so well known to you that any minute description in this report would seem superfluous. Yet, while refraining from such description, I deem it necessary to call your attention to the geology of the district, as it is believed that in no other route between the lakes and the Mississippi River are the natural elements used in construction found in such abundance and in such accessible positions. In fact the geological features of this route render it pre-eminent in

the matter of economy of construction.

In view of the fact that different styles of navigation are proposed on different parts of the route, I have divided it into three divisions. The first division consists of independent canal from Chicago to Joliet; the second division, extending from Joliet to La Salle, will consist of an improvement of the river by locks and dams, being virtually a continuation of the slack-water navigation projected in the river below La Salle. The third division consists of independent canal, corresponding to the line adopted and known as the Hennepin Canal, extending from the Illinois to the Mississippi River.

As it is proposed to draw the supply of water for the canal and river from the lake, all elevations are referred to the low-water plane of Lake Michigan; and as the course of the canal is laid down on the maps, it will not be necessary to

advert to that here.

First division.—The canal commences with an average water-section equal to 448 square feet, with a variable depth of from 6 to 8 feet of water. As will be noticed, its course coincides with a right line for a distance of 7½ miles, at which point it is deflected to the south and continues parallel to

the valley of the Des Plaines River until it unites with the latter at Joliet. The physical difficulties to be overcome along this line are of an ordinary character, being such as are common to works of this class in almost all parts of the country.

The first 14½ miles of canal are excavated through a compact blue clay to an average depth of 16 feet. On the latter half of the 15-mile rock-excavation begins, and, with the exception of a few short intervals, this material continues to

exist along the line to a point below Joliet.

At Lockport a section of the valley of the Des Plaines River was taken, which will be shown on the sheets accompanying this report, from which it will be seen that the valley is a little more than one mile in width, with a thin drift of clay over the rock, the river bed occupying at this point the central line of the valley.

As this had previously been designated as a favorable point at which to leave the canal for the river, I examined the valley with great care, and submit a section to show the superiority of the present location and the impracticability of any plan tending to a change in the direction mentioned.

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Prior to the year 1872, the summit-level of the Illinois and Michigan Canal was some 8 feet above the standard-level of Lake Michigan, and the quantity of water requisite to maintain navigation on the summit-level of the canal was supplied from Lake Calumet by a feeder and from the Chicago River by expensive pumping-machinery.

Sometime during the year 1866, the Board of Public Works of the City of Chicago entered into a contract with the State to cut down and reduce the summit-level of the canal to the

elevation of the lake.

The object of this work on the part of the city authorities was to obtain an outlet for the south branch of the Chicago River; that being a receptacle for the sewerage of a large

part of the city.

This contract was satisfied, the work completed, and navigation on the canal resumed July 18, 1872. The exertions and labors of the city to rid itself of a nuisance were not in vain; the residents of the city were relieved of a truly great evil, and the problem of securing a permanent and ample supply of water for the canal was practically solved.

Happy as such results were, the work, from its contracted dimensions afforded only partial relief; and recent drainage

improvements in the vicinity of the city have proved quite detrimental to and interfered very seriously with the city's

purposes and interests in respect to this work.

In view of the many benefits that would accrue to the city in case of a further enlargement of this canal, as contemplated, the question is believed to be pertinent, will the city assume her portion of the cost of such enlargement?

One of the important duties of this survey was to determine accurately the volume of water to be drawn from the lake to maintain a depth of water in the river after it should

be improved.

Experience on the summit-level of the canal, since it has been supplied from the lake, proves conclusively that the varying stages of water in the lake very materially affect navigation on this part of the canal. This fact is more noticeable during periods when the direction of the wind is parallel with the axis of the canal; the fluctuations in the elevation of the surface of the water being directly traceable to this cause.

EXTRACT FROM U. S. CHIEF OF ENGINEER'S REPORT 1880, AP-PENDIX EE, PAGE 1995. SURVEY OF ILLINOIS RIVER.

UNITED STATES ENGINEER OFFICE.

Снісадо, Іш., Мау 10, 1880.

General: I have the honor to submit the following report on a survey of the Illinois River, executed in pursuance of the act of Congress making appropriations for the improvement of certain rivers and harbors, approved March 3, 1879.

The question of a through line of water communication from the Mississippi to Lake Michigan, via the Illinois River, has been before Congress since an early date. In 1822, the State of Illinois was authorized to make through the public lands of the United States a route for a navigable canal connecting the Illinois River with Lake Michigan, and between that date and 1854, Congress had granted to the State 321,760 acres of land to assist in its construction. The canal was first opened to navigation in 1848, its cost up to that time being \$6,409,509.95; since then the state has spent a great deal towards its enlargement and maintenance. In the meantime several surveys, having in view the improvement of the Illinois River, have been made, the first in 1838 by Capt. Howard Stansbury, Topographical Engineers; the next of any considerable importance was made under the direction of General J. H. Wilson, in 1866, the object of which was "to obtain such specific and accurate information in regard to obstructions to navigation in that river as will enable you to submit estimates for its improvement, so that the largest boats navigating the Illinois and Michigan Canal, and steamboats drawing four feet of water, will be enabled to pass through the river to St. Louis during the season of extreme low water

without breaking cargo."

His report on this survey led Congress to direct a more complete survey in 1867 (act approved March 2), the object of which was to prepare plans and estimates "for a system of navigation by way of the Illinois River, between the Mississippi and Lake Michigan, adapted to military, naval, and commercial purposes." This duty was committed to a Board of Engineers composed of General J. H. Wilson and Mr. William Gooding, Civil Engineer, the latter having been for a long time the Chief Engineer of the "Illinois and Michigan Canal." The report of this Board was submitted to the Chief of Engineers under date of December 17, 1867, and is published in his annual report for 1868, pages 438 to 468. It recommended that the Illinois River be improved by the construction of five locks and dams, creating thereby a slack water system with a navigable depth of 7 feet at the lowest stage, from the mouth of the river at Grafton to Utica, 227 miles above; the lock chambers were to be 350 feet long, 75 feet wide, and the estimated cost of the entire work was \$1,953,600. To complete the through line to Lake Michigan, an enlargement of the canal was recommended, the estimated cost of this enlargement being, in round numbers, \$16,250,000.

No appropriations were made by Congress to carry out the plan of improvement above indicated, but the State of Illinois, in substantial conformity with that plan, has constructed two of the proposed locks and dams (viz, at Henry and Copperas Creek), at a cost of \$747,747, while the annual appropriations by Congress for improving the Illinois River (aggregating to date \$589,150) have been applied mainly to ameliorating its navigable condition by dredging channels through the worst bars, and constructing dikes and wing-dams for contracting the waterway. For a more detailed description of these operations I would respectfully refer to my report dated August 30, 1878 (which was published as House Ex. Doc. No. 81, 45th Congress, 3rd Session), a copy of which

is transmitted herewith.

The several surveys and reports above referred to gives so complete a description of the physical characteristics of the

route, and present the arguments in favor of its improvement so forcibly, that it seems unnecessary to extend this report by repeating what has been so fully set forth before; accordingly it is limited to a brief outline of operations on the last survey, and a statement of what is necessary to complete the improvement of the river.

A substantial improvement having been effected from its point of connection with the canal down to Copperas Creek Lock, it was decided to apply the \$5,000 allotted for our survey to the remainder of the river, viz, from Copperas Creek to Grafton, where the Illinois empties into the Mississippi.

Page 1998.

The laws of Congress require that reports of surveys of rivers and harbors shall contain "statements of all existing facts tending to show to what extent the general commerce of the country will be promoted by the several works of improvements contemplated by such examinations and surveys." In fulfillment of this requirement it seems only necessary to note that the improvement of the Illinois River, supplemented by the enlargement of the Illinois and Michigan Canal as heretofore proposed, will furnish a reliable and commodious channel of water communication from the Mississippi River to the Northwestern lakes; by this line the vast Mississippi Valley, and all the country tributary thereto, is brought into direct water communication with Lake Michigan, at the great City of Chicago, with its flood of commerce eastward and westward; the route exists as a practicable one of considerable importance today, and the question is simply one of enhancing its value by increasing its capacity to a degree commensurate with the important interests involved.

Other routes have been examined and studied with care but neither of them occupies so central a position, can be built so soon, and with such certain results, maintained so economically, nor utilized through so great a part of the year.

Considering this simple statement, the facts so fully set forth in previous elaborate reports, and noting the wonderfully rapid development of the entire western country, it would seem that nothing further is necessary to indicate "to what extent the general commerce of the country will be promoted" by the contemplated improvement, nor to show how desirable it is that the work should be accomplished with the least delay practicable.

The total amount appropriated for the improvement of the Illinois river from 1869 to date is, From which there has been expended \$545,909.57

\$589,150.00

as follows:

For foundation of Copperas Creek

\$62,358,90

For dredging, wing dams, etc., including machinery,

483,550.67

Total expended,

\$545,909.57

Leaving balance available May 8,1880 43,240.43

\$589,150.00

I am very respectfully your obedient servant, G. J. Lydecker,

Major of Engineers.

Brig. Gen. H. G. Wright, Chief of Engineers, U. S. A.

EXTRACT FROM THE CHIEF OF ENGINEER'S REPORT 1884, APPENDIX HH, p. 1957, ENTITLED "PRELIMINABY EXAMINATION OF ILLINOIS AND DES PLAINES RIVERS BETWEEN LA SALLE AND JOLIET, ILLINOIS."

United States Engineer Office,

CHICAGO, ILL., September 2, 1882.

General: I have the honor to present the following report in regard to the proposed survey of the Illinois and Des Plaines Rivers from Joliet to La Salle, Ill., as provided for in the river and harbor act of August 2, and assigned to my

charge by letter of August 11.

Several surveys have been made of the route by the State and by the General Government, and I have not deemed it necessary therefore to make a personal examination of the stretch of river in question, in order to report upon the necessity of an instrumental survey. I have examined the maps and consulted the reports and other sources of information, and deem it necessary to make survey, estimates for which are presented herewith.

The necessity of the improvement derives its importance from several considerations. The State has improved the river for ship navigation from La Salle to Copperas Creek, and the Government is now engaged in continuing the im-

provement thence to the mouth. I am directed to report upon the cost of enlarging the Illinois and Michigan Canal, which extends from Lake Michigan to La Salle. This work, if ever carried on, will give through navigation for large vessels from the lake to the Mississippi. The canal runs in close proximity to the river the entire distance from Joliet to La Salle, and in making up the estimates for the enlargement of the canal it will be necessary to discuss whether or not it will be more economical to enlarge the canal between those two points, or to improve the river and abandon the other.

Very respectfully, your obedient servant,

W. H. H. BENYAURD, Major of Engineers.

Brig. Gen. H. G. Wright, Chief of Engineers, U. S. A.

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SUBVEY OF ILLINOIS AND DES PLAINES RIVERS BETWEEN LA SALLE AND JOLIET, ILLINOIS.

UNITED STATES ENGINEER OFFICE,

CHICAGO, ILL., March 5, 1884.

General: I have the honor to present the following report upon the survey of the Des Plaines and Illinois Rivers from Joliet to La Salle, with estimates of cost of improvement, as provided for in the river and harbor act passed August 2, 1882.

The survey party, under the charge of Mr. George Y. Wisner, assistant engineer, was not sent into the field until the 1st of October, 1883, as it was deemed better to wait and take advantage of the very lowest stage of water that could be found, not only as a matter of economy, but as affording the advantage of obtaining the fullest information when the rivers were in their worst condition, upon which state it was necessary to base the proper plan of improvement.

The survey was commenced at Dam No. 1 on the Des Plaines River, at Joliet, and continued to a point on the Illinois River near La Salle, where the Illinois and Michigan Canal enters the pool created by the lock and dam constructed by the State

at Henry.

The rivers have an average width of about 600 feet, with banks from 8 to 23 feet in height above low water, so that within ordinary stages the stream flows within fixed banks. The oscillation between high and low water is about 15 feet, though a height of 23 feet has been recorded, occasioned by

an ice-gorge.

The fall in the low-water surface between the points indicated above, a distance of 64.2 miles, is 100.25 feet. This fall is not, however, equally distributed over the entire distance, but occurs at various points, principally at the ripples separating the different pools, and amounting in some cases to 10

feet per mile.

It is evident, after consideration, that the only feasible plan to render the stream navigable is to slackwater the entire dis-This can be accomplished by the construction of nine locks and dams, the cost of which depends upon whether the plan adopted shall be in conformity with that now in course of execution for the lower Illinois River, or whether the locks shall be of the size recommended for the Hennepin Canal. addition to the requisite locks and dams, the plan also contemplates the construction of a short canal at the falls of Joliet, and one at Marseilles. The location of the various structures and the two canals were fixed upon, so that there should be no conflict between the United States and persons owning valuable manufacturing interests along the river, where water power is used. Certain low lands will necessarily be submerged if the plan be carried into execution; very little of it, however, is of any considerable value, and can very easily be estimated for. On this point the notes of the survey are very complete, and the maps are constructed showing the contours at every five feet elevation, so that the amount and character of the land submerged at any height above low water can readily be determined.

The Illinois River, below the termination of the present survey, has been rendered navigable by the State by the construction of the locks and dams at Henry and Copperas Creek. Two additional locks are now in course of construction by the Government, which will carry the navigation through to the Mississippi. All the locks are 350 feet long between gates, by 75 feet wide, and adapted for the passage of the largest size

steamers navigating the river.

With the improvement of the river now in question carried on, navigation will be brought to within 33 miles of the lake, and this stretch can be opened by improving the Des Plaines higher up, and by enlarging the present Illinois and Michigan Canal. In the report I have estimated for locks of the same size as those on the lower river, and with the same lift—7 feet. At the same time, as the question of the construction of the Hennepin Canal and the enlargement of the Illinois and

Michigan Canal is under consideration, I have had other estimates made for locks of the same size as those recommended

for these works.

As stated in my preliminary report under date of September 2, 1882, I had intended instituting a comparison between the cost of enlarging the Illinois and Michigan Canal between Joliet and La Salle and that of improving the rivers between the same points; but as the survey of the latter was not at that time authorized, I merely confined my report on the Illinois and Michigan Canal to the cost of enlargement throughout its entire length, and without making any change to the river route. With the data furnished by the present survey it has been ascertained that the cost of enlargment of the canal for the middle-sized locks is less than what the improvement of the river would cost for the same class of works, while in the case of the larger locks the expense would be greatly in The additional cost of the river favor of the river route. route in the first instance would be offset by the lesser amount that would be required for maintenance, repairs, &c., as the long line of canal, with its aqueducts, feeders, weirs, &c., would be a constant source of expense. The river route has also the advantage, when it is considered that we have navigation on a stream 600 feet wide instead of the narrow channel of the canal.

Looking at the matter in an engineering point of view, it is difficult to understand what led originally to the construction of the canal, rather than the improvement of the natural channel of the river. Should the Illinois and Michigan Canal be accepted by the Government, and its enlargement undertaken, that part between Joliet and La Salle should be abandoned

and the river route between these points adopted.

Another point in the contemplated improvement, or in the acceptance of the Illinois and Michigan Canal, demands notice. As before mentioned, two locks and dams are in course of construction on the lower river by the government, above which there is a stretch of 88 miles of river improved by and now under the control of the State. Should the United States continue the improvement between Joliet and LaSalle, there will then be a part of the river forming a link between the imper and lower portions over which the state now exercises control and upon which tolls are collected for the passage of boats through the locks.

The act of the legislature of the state ceding the Illinois and Michigan Canal did not, as I understand, include the

locks and dams at Henry and Copperas Creek, but only the

canal as originally constructed.

The estimated cost of improvement, with locks having chambers 350 feet long and 75 feet wide is \$3,433,562, and for the size of locks adopted for the Hennepin Canal, 170 feet by 30 feet, \$1,975,446.

There is transmitted herewith the report of Mr. George Y. Wisner, assistant engineer, to which reference can be made

for details of survey, &c.

The maps will be completed in the course of the present month and forwarded to the Department.

Very respectfully your obedient servant,

W. H. H. BENYAURD, Major of Engineers.

To the Chief of Engineers, U.S.A.

REPORT OF MR. GEORGE Y. WISNER, ASSISTANT ENGINEER.

CHICAGO, ILL., February 23, 1884.

Major: I have the honor to make the following report on the survey of the Des Plaines and Illinois Rivers from Joliet to LaSalle, Ill., and to submit estimates of cost for improvement of the rivers by locks and dams, so as to give a minimum depth of seven feet at low-water stage.

The survey was commenced at Dam No. 1 on the Des Plaines River, at Joliet, and continued to the mouth of the Illinois and Michigan Canal, on the Illinois River, at LaSalle. The fall of the low-water surface from above Dam No. 1 to LaSalle, a distance of 64.2 miles was found to be 100.25 feet. The greater portion of this fall, however, occurs in less than half the above distance, at the ripples separating the various pools, and which in some cases amount to 10 feet per mile.

The river for the entire distance flows either over a rock bed or a strata of earth of only a few feet thickness, overly-

ing the rock formation.

With one exception, at Treat's Island, all the locks and

dams may be established on rock foundations.

There are no indications of any material change of location having occurred in the river bed for a number of years. A comparison of results with those from the survey made by Mr. Doran in 1874 shows that scour has occurred in the bed of the river, amounting in some instances to 12 feet in depth, but otherwise the general outlines of the river-bed remain the same.

The average width of the river is about 600 feet, with banks from 8 to 25 feet in height above low water, or such that at ordinary stages the stream flows within fixed banks.

The damage to farming lands from raising the low-water surface so as to give a minimum depth of 7 feet will not be

of any great amount.

Treat's Island and a large island just below Buffalo Rock, will be submerged so as to be of little value. At Marseilles about 50 acres of land will have to be purchased for the pro-

posed canal around the rapids.

From an examination of high-water marks it was found that in several places where the river has been gorged with ice the surface rose to 23 feet above the low-water plane, but ordinary high water probably in no case exceeds 15 feet above low stage. All bridges across the river will require draw spans to admit the passage of boats at high water.

The plan proposed for the improvement of the river at Joliet is a lock of 10 feet lift at Dam No. 1, and a canal 12,500 feet long from Dam No. 2 at the foot of Jefferson Street, to the head of the pool below, known as Lake Joliet. Guard gates will be required at the head of this canal, and a com-

bined lock of 20.8 feet lift at the lower end.

This plan was adopted for the reason that valuable manufacturing interests derive water power from Dam No. 2, and from the Adams Dam, 2300 feet below, which power would be practically ruined if the surface of the river were raised

so as to give a depth of 7 feet.

It will also be seen from the accompanying maps that the river below the Adams Dam is shallow, with channel obstructed with numerous small islands, and if improved by raising water surface by a dam at the head of Lake Joliet, the pool thus formed would, in all probability, soon fill up with deposits from the Illinois and Michigan Canal, so that a navigable way could only be maintained by continual dredging.

Lake Joliet, however, is 5 miles long and 10 feet to 20 feet deep, and consequently, by commencing slack water improvement at the head of this pool, there will be little or no liability of the navigable channel becoming obstructed by de-

posits.

At the lower end of this pool Treat's Island, 4,500 feet long, is situated, past which the low water plane of the river

has a slope of 10 feet to the mile.

At the lower end of Treat's Island (6.3 miles below canal) Lock No. 3 is located, having a lift of 9.9 feet, and dam 350 feet in length. This lock will probably have to be built on a timber foundation. No borings were made, but the strata of sand and gravel overlying the rock formation probably does not exceed 12 feet in thickness.

Below lock number 3 a pool from 4 feet to 15 feet deep extends down to the mouth of the DuPage River (two miles), below which there is a ripple three-quarters of a mile long,

having a low-water slope of 2 feet per mile.

From this point the river is from 10 feet to 20 feet deep to within a short distance of the mouth of the Kankakee River (three miles), the junction of which with the DesPlaines forms the Illinois. At the mouth of the Kankakee the river flows over a rock bed, and for a distance of 1.7 miles has a low-water slope of 4.4. feet per mile.

EXTRACT FROM A REPORT OF MAJOR HANDBURY, CHIEF OF ENGINEER REPORTS 1887, APPENDIX II, p. 2119, ENTITLED "IMPROVEMENT OF ILLINOIS RIVER, ILLINOIS."

The project now in the course of execution for the reach of the Illinois River lying between the state lock at Copperas Creek and the mouth, a distance of 135 miles, contemplates the construction of two locks and dams and the dredging of a channelway where necessary, so as to insure a continuous depth throughout of not less than 7 feet at low water.

The sites selected for the locks and dams are one at Kampsville, about 30 miles above the mouth of the river; the other at LaGrange, 45 miles above Kampsville. These locks are 350 feet long and 75 feet wide, with 7 feet over miter-sills at

low water.

The ultimate object of this improvement is to provide a channelway from the lower end of Lake Michigan to the Mississippi River of sufficient capacity to accommodate large-sized Mississippi River boats, so that the products of the country may be carried from the Lake to the Gulf without breaking bulk; also to enable vessels of war of considerable capacity to pass freely from the Gulf of Mexico into the defenseless waters of our northern lakes, should the exigencies of our foreign relations ever require this to be done.

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When this work is completed it will then be practicable for the large steamers belonging to the Upper and Lower Mississippi, the Ohio, and Missouri Rivers to come with their unbroken cargoes to within 100 miles of Lake Michigan. All this can be brought about by an expenditure on the part of

the government of less than \$600,000.

The Illinois River, from the western terminus of the Illinois and Michigan Canal at LaSalle to Copperas Creek, about 80 miles below, has been improved by the State of Illinois by means of two locks and dams similar to those in process of construction by the United States on the river below. From LaSalle to Joliet the Illinois and Des Plaines Rivers have been carefully surveyed, and plans and estimates of cost for their improvement to the same navigable capacity as the river below have been made and submitted to Congress. The report on this project submitted by Maj. W. H. H. Benyuard, Corps of Engineers, U. S. Army, may be found in the Chief of Engineer's Report for 1884, page 1958. The estimated cost of improving this reach of the river is \$3,433,562. The distance is 64 miles and the fall 100 feet. Congress has now before it the engineering data showing the feasibility and cost of a water communication between the Mississippi River and a point 30 miles distant from navigable water leading into Lake Michigan sufficiently commodious for the commercial and military exigencies of the country, and from this point to the lake perfectly practical routes over which the line can be constructed are known to exist. It only remains for Congress to provide the means for making the necessary surveys and estimates of cost for continuing this work from Joliet to Lake Michigan, when it will have the engineering features of the whole subject before it in a shape necessary for intelligent legislation. I estimate that about \$10,000 will be sufficient to defray the expenses of the necessary surveys and examinations and preparation of the plans and estimates of costs of the work.

The United States and the State of Illinois have long been committed to the project of opening a water communication between the Mississippi River and the northern lakes of capacity sufficient for the wants of commerce and for the exigencies of our national defense, should these ever arise. The amount expended by the United States to the end of the present fiscal year in carrying out this project is \$680,633.42, exclusive of \$62,359.80 expended on the foundation of the Copperas Creek Lock, which was afterwards turned over to the State. The cost of the locks and dams built by the State of

Illinois at Copperas Creek and Henry was \$747,747.

The distance by this route from the Gulf of Mexico to the southern end of Lake Michigan is about 1,620 miles. When the projected improvement of the Illinois River below Cop-

peras Creek, on which we are now working, has been finished, more than 1,520 miles of this distance will be available for the water transportation of commerce in bulk between these points. Pushing this improvement through to the lake, the connecting line will be formed which will join the northern lakes with the vast net-work of navigable rivers whose waters flow into the Gulf of Mexico on a scale to a certain degree commensurate with the importance of the commerce that will be affected by it. The mere fact that such a route is available will serve as a wholesome regulator to the rates that would be exacted by other methods of transportation were this one not in existence. Besides the immense commercial advantages that may be expected from the completion of the project, there are military and naval exigencies that might easily arise where it would figure as a prominent factor in the problem of our national defenses. From whatever point we look at the subject there is nothing local or sectional in it. It is true that all the work to be done happens to be in the State of Illinois. The benefits to be derived belong to the nation at large. It is fortunate, too, that at this time the subject is unencumbered by any phase of a political character. The problem of connecting Lake Michigan with the Mississippi River by a commodious waterway, that could be used for commercial, military and naval purposes, has received attention from our most thoughtful statesmen from the day of Albert Gallatin to the present.

The question of enlarging the Illinois and Michigan Canal from Joliet to Chicago, Ill., to a capacity equal to the low water capacity of the improved Illinois River has been discussed at some length by General J. H. Wilson, in a report to the Chief of Engineers, U. S. Army, published as House Ex. Doc. No. 16, 40th Congress, first session. Since the date of that report the conditions which affected the problem in its most essential features have materially changed. Additional engineering data that we are not now in the possession of have become a matter of absolute necessity, and must be collected and compiled before all the facts necessary to a thorough understanding of the subject can be laid before Congress. The Board of Engineers appointed under provisions of the river and harbor act approved August 5, 1886, to examine and report upon the Illinois and Michigan Canal and the proposed Hennepin Canal, says in its report (House Ex. Doc. No. 79, 49th Congress, 2nd session) that "the waterway from Chicago to Grafton, on the Mississippi River, is a most important one, and when completed there is little doubt

that it will richly pay for itself in the reduction and regulation of freights." These remarks are concurred in by the Chief of Engineers in his letter submitting this report to the Secretary of War. In the same report the Board remarks:

In view of the possibilites of the case, it would appear that whatever enlargement of the canal is made from Joliet northward should not be carried further than the "Sag," a point whence the line of the canal could be easily diverted to a more favorable terminus.

The Secretary of War, in laying this matter before Con-

gress, remarks upon this point:

In this connection another question is suggested by the report of the Board of Engineers. At present the canal has its northern terminus in the South Branch of the Chicago River, about five miles from Lake Michigan. This branch runs through the central business portion of Chicago and is crossed by numerous draw-bridges. At present these bridges are a great impediment to navigation and to the land traffic of Chicago. If this river becomes the only outlet to the large commerce that may follow the opening of this new route of transportation between the Mississippi River and Lake Michigan, another outlet for the canal will be necessary, and economy and convenience may demand another channel to the waters of Lake Michigan. As to the cost of such a change, should it be necessary, we have no knowledge, no preliminary surveys of the country, with a view to the constructing of a new route to the lake, having been made.

In my report to the Chief of Engineers dated February 10, 1886, supplementary to that of Major W. H. H. Benyaurd, Corps of Engineers, on the subject of the Hennepin Canal, published in House Ex. Doc. No. 117, 49th Congress, 1st Ses-

sion, I have the honor to state:

Before taking steps looking to the enlargement of the Illinois and Michigan Canal in the interests of Commerce, or as a military expedient, the advisability is suggested of ascertaining whether or not some route can be found from Joliet to Lake Michigan at a point where better facilities can be provided for handling the large commerce of this section. It is thought by some that a practical route exists between the valleys of the Des Plaines and Calumet Rivers, along which a canal such as will accommodate the largest vessels using the improved Illinois River can be constructed, at a cost less than that

estimated for the enlargement of the Illinois and Michi-

gan Canal from Joliet to Chicago.

Before definitely locating that portion of this route which is to lie between Joliet and Lake Michigan, and which will involve in its construction the expenditure of a very considerable amount of money, every possible route should be examined, and every engineering phase of the problem should be considered. For these reasons I venture to respectfully suggest the advisability of calling the attention of Congress to the necessity for making available the sum of \$10,000; as much thereof as may be necessary to be expended in examinations and surveys between the southern end of Lake Michigan and the Des Plaines River at or near Joliet, Ill., and on the preparation of plans and estimates of cost of constructing, along the most practical route so determined, a waterway having sufficient capacity to accommodate the same class of vessels and commerce that the present improved condition of the Illinois River is designed to accommodate.

EXTRACT FROM H. R. Doc. 263, 59TH CONGRESS, 1ST SESSION, KNOWN AS THE ERNST SURVEY OF 1902-1905.

LETTER OF THE SECRETARY OF WAR.

WAR DEPARTMENT.

Washington, December 18, 1905.

Page 3.

Sir: I have the honor to transmit herewith a letter from the Chief of Engineers, U. S. Army, dated December 12, 1905, together with copies of reports of the Mississippi River Commission and a Board of Engineers dated February 28 and August 26, 1905, respectively, of a survey, with plans and estimates of cost, for a navigable waterway 14 feet deep from Lockport, Ill., by way of Des Plaines and Illinois Rivers, to the mouth of said Illinois River, and thence by way of the Mississippi River to St. Louis, Mo., and for a navigable waterway of 7 and 8 feet depth, respectively, from the head of navigation of Illinois River at LaSalle, Ill., through

said river to Ottawa, Ill., made in compliance with the provisions of the river and harbor act of June 13, 1902.

Very respectfully,

WM. H. TAFT, Secretary of War.

The Speaker of the House of Representatives.

LETTER OF THE CHIEF OF ENGINEERS.

WAR DEPARTMENT.

OFFICE OF THE CHIEF OF ENGINEERS,

Washington, December 12, 1905.

Sir: The river and harbor act approved June 13, 1902,

contained an item as follows:

The sum of two hundred thousand dollars, or so much thereof as may be necessary, is hereby appropriated for making such surveys, examinations, and investigations as may be required to determine the feasibility of, and to prepare and report plans and estimates of cost of, a navigable waterway fourteen feet in depth from Lockport, Illinois, by way of the Des Plaines and Illinois rivers to the mouth of said Illinois River, and from the mouth of the Illinois River, by way of the Mississippi River, to Saint Louis, Missouri: Provided, That twenty-five thousand dollars of said sum, or so much thereof as may be necessary, may be expended by the Mississippi River Commission in making surveys, examinations, and investigations herein required from the mouth of the Illinois River to Saint Louis; provided further, that the Secretary of War shall appoint a board of three engineers the surveys, examination and investigations to make hereinbefore required from Lockport, Illinois. River. River and Illinois Plaines the Des mouth of said Illinois River, and that all such surveys, examinations, and investigations shall be made to determine the feasibility of, and to prepare and report plans and estimates of cost of, a navigable waterway fourteen feet in depth from Lockport, Illinois, to Saint Louis, Missouri.

The said Mississippi River Commission shall make said report covering such proposed improvement from the mouth of the Illinois River to Saint Louis and the said board of engineers shall make such report from Lockport, Illinois, to the mouth of the Illinois River: And provided further, That the said board of engineers shall also make such surveys, examinations, and investigations as may be required to determine the feasibility of, and to prepare a report and plans, and estimates of cost, of, a navigable waterway seven feet in depth and of a navigable waterway eight feet in depth from the head of navigation of the Illinois River at LaSalle, Illinois, through said Illinois River to Ottawa, Illinois, and said board of engineers shall make such report of said navigable waterways of seven and eight feet, respectively, of said Illi-

nois River from LaSalle to Ottawa, Illinois.

In accordance with this provision, a Board of officers of the Corps of Engineers, consisting of Col. Oswald H. Ernst, Lieut. Col. Charles J. Allen, and Maj. Thomas L. Casey, was appointed and charged with the duty of making the surveys, examinations, and investigations from Lockport, Ill., by way of the Des Plaines and Illinois rivers, to the mouth of the Illinois River. By operation of law, Lieut. Col. Charles J. Allen, Corps of Engineers, one of the members of the board, was retired from active service as brigadier-general January 8, 1904, and was replaced by Maj. James L. Lusk, Corps of Engineers, April 21, 1904, who in turn was relieved on account of ill health on April 6, 1905, being replaced by Lieut. Col. W. H. Bixby, Corps of Engineers. This Board was also charged with the duty of making the necessary surveys, etc., of the waterways named in the final proviso of the item quoted above.

The Mississippi River Commission was charged with the duty of making the required surveys, examinations, and investigations from the mouth of the Illinois River to St.

Louis, Mo.

The Board of Engineers above referred to and the Mississippi River Commission have made their reports, which are

now submitted for transmission to Congress.

To provide the 14-foot channel from Lockport by way of the Des Plaines and Illinois rivers to the mouth of the Illinois River, the Board proposes to canalize the river from Lockport to Utica by 9 locks and 5 new movable dams, and to utilize the open river from Utica to Grafton by removing the four existing dams and dredging a channel 200 feet wide at the bottom. It is thought that such a channel will have the requisite depth of 14 feet when the natural discharge of the river is augmented by the contemplated flow of about 10,000 cubic feet per second from the Chicago Drainage Canal.

The channel will connect with the Chicago Drainage Canal by a lock in the dam which is now under construction by the Sanitary District of Chicago at Lockport; it then follows the canalized river in the main, having lateral canals, each

about 3 miles long, at Marseilles and Joliet.

The Board estimates the cost of the channel from Lockyort to Grafton at \$23,543,582. This estimate is based on concrete locks 600 feet long, 80 feet wide, and 14 feet deep over the miter sills. The Board remarks that this depth, while corresponding to the channel mentioned in the act. will not provide for any future increase, which may be made possible by augmenting the flow through the Chicago Drainage Canal above 10,000 cubic feet per second. The Board states that, to take full advantage of such possible increase in navigable depth, the locks would have to be entirely rebuilt, or would have to have increased depths given to them at the present time. To increase the depth over the miter sills 6 feet now would add about \$1,376,000 to the cost of the The plan proposed is based upon the assumption that the abstraction of 10,000 cubic feet of water per second from Lake Michigan, a quantity contemplated in the State legislation affecting the drainage canal, will eventually be permitted by competent Federal authority.

In this connection the Board states that it does not condemn the present plan of taking 10,000 cubic feet per second, believing as it does that some such amount will be needed to protect the lives and health of the people of a great city and of a populous valley; but it invites attention to the fact that if a much larger amount be taken it will be necessary to construct remedial works elsewhere, and that these are, or should be, of an international character. It is led to make this remark by the attitude of the Illinois legislature and of the other principal advocates of this enterprise, which is that the 14-foot waterway is only a beginning, and that a much deeper channel ultimately should be constructed, which means that a much larger volume of water must be taken from Lake

Michigan. It is the opinion of the Board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case. It is impossible to fix a limit to the future growth of Chicago. In a future not remote larger amounts of water may be needed for sanitary purposes, and channels deeper than 14 feet will then become practicable, in the open alluvial portion of the Illinois Riyer."

Very respectfully,
A. Mackenzie,
Brig. Gen., Chief of Engineers, U. S. Army.
H. Taft,
Secretary of War.

EXTRACT FROM THE REPORT OF THE BOARD, PAGE 9, ENTITLED CHICAGO DRAINAGE CANAL.

Hon. WM. H. TAFT.

Besides being a highway of commerce, the Illinois and Michigan Canal has from the beginning served to carry off the sewage of Chicago. The Chicago River has always been the main receptacle of the sewage of the city, and as the volnme of sewage has increased with the growth of the city additional facilities for discharging it into the canal have become necessary. When the canal was opened in 1848, a pumping plant was established at Bridgeport, where it joins the Chi-In 1860 the capacity of this plant was nearly cago River. doubled, being increased to about 400 cubic feet per second. Later on the summit level of the canal was cut down so as to provide a continuous gravity flow from the Chicago River and Lake Michigan. That work was completed in 1871 and the pumping plant abandoned. In 1883 a new pumping plant was brought into use, having a nominal capacity of 750 cubic feet per second, but it soon became evident that the discharging capacity of the old canal was quite inadequate to carrying the volume of water required to dilute the sewage and that a new and greatly enlarged channel must be provided. The Chicago Drainage Canal was then constructed and was brought into use in January, 1900. It has not yet been completed to its full capacity as designed. When fully completed it will have a capacity of about 10,000 cubic feet per second, flowing at a low velocity. As now constructed, it has a depth of about 22 feet and a bottom width in different parts 110 feet, 160 feet and 202 feet, respectively. stitutes a navigable channel able to accommodate the largest vessels now navigating the Great Lakes. It extends from the Chicago River to Lockport, where it discharges into the Des Plaines River and is now being extended 2 miles farther to a new power house. With the six miles of the Chicago River and the 2 miles extension just mentioned it provides a wide and deep channel for a distance of 36 miles from Lake At present it has no navigable connection with the streams below, but under State legislation a connection is to be made. It creates an important water power.

Although the primary object of the Chicago Drainage Canal was the discharge of Chicago sewage, its function as a channel, for navigation, was kept in view from the beginning. All of the bridges over it are draw bridges with ample openings. The original act of the Illinois legislature providing for its construction dated May 29, 1889, contained the

following item, viz.:

24. When such channel shall be completed, and the water turned therein, to the amount of three hundred thousand cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the General Government shall improve the Des Plaines and Illinois rivers for navigation, to connect with this channel, said General Government shall have full control over the same for navigation purposes, but not to interfere with its control for sanitary or drainage purposes.

As its utility for sanitary or drainage purposes is dependent upon the supply of water which it may obtain from Lake Michigan, a matter wholly at the discretion of the Federal Government, the degree of control which the State offers to the United States in this act, although limited, is probably sufficient. It is conditional, however, upon the improvement by the Federal Government of the Illinois and Des Plaines rivers, and the degree of improvement is described in section 23 of the above mentioned State law, which contains the following language:

If at any time the General Government shall improve the Des Plaines or Illinois rivers, so that the same shall be capable of receiving a flow of 600,000 cubic feet of water per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow above 300,000 cubic feet of water per minute, from such channel may cause to private property, so as to save harmless the said district from all liability therefrom, then such sanitary district shall within one year thereafter enlarge the entire channel leading into said Des Plaines or Illinois Rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet per minute, with a current of not more than three miles per hour, and such channel shall be constructed upon such grade as to be capable of producing a depth of water not less than eighteen feet throughout said channel, and shall have a width of not less than one hundred and sixty feet at the bottom.

The taking of large quantities of water from Lake Michigan for drainage purposes has not been authorized by Con-It has been the policy of the War Department thus far to regulate the quantity of water which is admitted to the canal by the necessities of navigation in the Chicago The capacity of that stream at present is such that not more than about 4,200 cubic feet per second can pass without creating velocities which will unreasonably obstruct navi-The quantity of water admitted to the canal is, for the present, limited to that amount, or, as expressed in the permit of the Secretary of War, to 250,000 cubic feet per minute. This is less than is required by the State law. It will no doubt be increased as the obstructions in the Chicago River are removed, and its discharging capacity increased, a work upon which the Sanitary District is now engaged. In preparing its estimates the Board has assumed that the full discharge of 10,000 cubic feet per second contemplated in the plans of the Sanitary District will eventually be permitted by the Secretary of War.

VESTED RIGHTS.

The effect upon the level of Lake Michigan of withdrawing 10,000 cupic feet per second for an indefinite period has been the subject of an elaborate investigation under the office of the Lake Survey in Detroit, and the conclusion reached is that the final effect will be to lower the level about 6 inches. (See Annual Report of Chief of Engineers for 1900, p. 5401, and for 1902, p. 2779 and p. 2825; also for-1904, p. 4120.) Oscillations of more than 6 inches in the level of the lake's surface are very common, often occurring hourly for many hours in succession, while oscillations of 2 or 3 feet within an hour are not uncommon. Still greater oscillations within a year or series of years occur, all from natural causes. Moreover, during a severe winter the discharge of St. Clair River is reduced by ice to less than one-third its normal discharge, the remaining two-thirds being stored up in Lakes Huron-Michigan and raising their levels; and the difference between the total discharge during a severe winter and the discharge during a mild winter will probably equal, or nearly equal, the discharge of the Chicago Drainage Canal for a A permanent average lowering of 6 inches in the lake's level, therefore, is not easily observed and will probably not be noticed by navigators. Nevertheless the effect is real and important. Evidently there is a limit to the amount of water which can be taken from the southern end of Lake Michigan without compensating works at the outlet of Lake Huron. The Board does not condemn the present plan of taking 10,000 cubic feet per second, believing as it does that some such amount will be needed to protect the lives and health of the people of a great city and of a populous valley; but it invites attention to the fact that if a much larger amount be taken it will be necessary to construct remedial works elsewhere, and that these are, or should be, of an It is led to make this remark by the international character. attitude of the Illinois legislature and of the other principal advocates of this enterprise, which is that the 14-foot waterway is only a beginning, and that a much deeper channel ultimately should be constructed, which means that a much larger volume of water must be taken from Lake Michigan. the opinion of the Board that the sanitary reasons for the abstraction of water so far exceed and overshadow the commercial reasons that the amount should be strictly limited by the sanitary necessities of the case. It is impossible to fix a limit to the future growth of Chicago. In a future not remote larger amounts of water may be needed for sanitary purposes, and channels deeper than 14 feet will then become practicable in the open alluvial portion of the Illinois River.

The natural discharge of the Illinois River at La Salle varies from about 500 cubic feet per second at the lowest stage to about 85,000 cubic feet during floods. The effect of adding thereto 10,000 cubic feet per second is to raise the water surface at all stages and to increase the extent and duration of overflow upon the bottom lands of the valley. Some damage will be done to these lands; in many cases no doubt small, but in all cases sure to be exaggerated by the owners. A multitude of damage suits is to be expected. With the discharge limited, as it now is, to 4,200 cubic feet per second, 224 suits have been brought against the trustees of the Sanitary District of Chicago, the claims aggregating \$4,-Making due allowance for exaggeration of claims, a considerable sum of money is involved, besides much litiga-In the State legislation quoted above it is proposed that the Sanitary District of Chicago shall asume responsibility for damages caused by the discharge of 5,000 cubic feet per second, and that for additional damages caused by. amounts greater than 5,000 cubic feet the United States shall be responsible. The introduction of dams in the portion of the route where dams will be required to secure the prescribed depth has a tendency to further increase the overflow. To keep this at a minimum it is proposed to make the dams of the movable type, which shall have no effect upon the water surface except at low and medium stages.

The steep slope of the Des Plaines River and of the Illinois River above Utica is favorable to the development of water power. Rights of this nature have acquired additional importance with the recent increase in the discharge of the drainage canal, and will acquire still further importance with the furthe increase contemplated. An important water power has been developed by the State of Illinois at Joliet and is now in use under lease by a private corporation. The Sanitary District of Chicago is engaged in the construction of works for the development of water power just above

Joliet. An important water power is in use also at Marseilles. Various other schemes for the development of water power have been projected. In all such cases fixed dams, with their resultant back flowage, are a necessity. In fixing the location and height of its dams the Board has endeavored to avoid the injury of any of these schemes. It has succeeded in doing this for all that are developed and probably also for those that are undeveloped. It has accepted the levels of the pools at and above Joliet as fixed by the dam now in existence at the former and that under construction at the latter; and at Marseilles the canal around the rapids has enabled it to avoid the power dam at that place entirely. At other places economy in excavation and avoidance of overflow have been the guiding considerations. The best development of water power would no doubt in some cases call for a different arrangement. Fewer dams and those of a greater height and of the fixed type might, from that point of view, be desirable. The plan submitted is not designed to develop water power; but there will probably be no difficulty in modifying it so as to conform to such development if those who are to benefit thereby will co-operate with the Govern-They should pay the cost of the dams and the damages from flowage, which is no more than they would be compelled to do if the Government made no improvement.

RESOLUTION OF APRIL 21, 1891, OF THE BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO.

"Resolved, That this Board hereby ordains that The Sanitary District of Chicago do forthwith enter upon, use, widen, deepen and improve the Chicago River from its mouth at Lake Michigan to the South Branch thereof, and also the South Branch thereof, together with the South and West Forks thereof so as to make the same a proper and sufficient supply channel for the main channel heretofore surveyed from the Chicago River to Joliet; and further, that the Acting Chief Engineer be, and he is hereby, directed immediately to investigate and report upon the capacity of said River and its said South Branch and Forks for that purpose, and also as to any

changes that should be made therein, and that a copy of this resolution, certified by the Clerk, be forthwith transmitted to the Mayor and Common Council of the City of Chicago, and the Secretary of War of the United States."

Proceedings of the Board of Trustees of the Sanitary District of Chicago, 1890-1891, page 173. EXTRACTS FROM THE NEGOTIATIONS BETWEEN THE UNITED STATES AND GREAT BRITAIN REFUSING THE UNITED STATES THE USE OF THE ST. LAWRENCE RIVER.

Extracts from Message of the President of Jan. 7, 1828, State Papers 1st Session 20 Congress, Vol. 2, Doc. 43, Page 8, entitled "Extract of a Dispatch from Mr. Rush to Mr. Adams,

Dated London, August 12, 1824."

"The act of parliament of August 5, 1822, having immediate relation to the commercial intercourse between the United States and the British continental possessions in their neighborhood, I naturally regarded it as your instructions to me had done in connection with the act of June 24, 1822. This brought under consideration our claim to the navigation of the St. Lawrence. Between this question and the questions of commercial intercourse under the act of June, 1822, the British plenipotentiaries were constantly unwilling to acknowledge any connection. Nevertheless, looking to your instructions, and as well to the reason of them as to their authority, I treated the two questions as belonging to one and the same general subject. They asked whether, taking the two acts of parliament together, the United States did not already enjoy the navigation of this river? I said that they did; by the act of June 24, 1822, they enjoyed it from the ocean to Quebec; and by that of August 5, 1822, from any part of the territories of the United States to Quebec. But from the fact of the colonial government in Canada being invested with a discretionary power to withdraw the latter of these concessions by excepting any of the Canadian ports from those to which our vessels were made admissible, it followed that our enjoyment of the navigation of this river was rendered contingent upon British permission. This was a tenure not reconcilable in the opinion of the government of the United States with the growing and permanent wants of their citizens in that portion of the Union, or with the rights It was due to both these considerations that it should stand upon a different tenure, and the time had arrived when it was desirable that the two nations should come to an understanding upon a question of so much importance."

"The British plenipotentiaries next asked, whether any question was about to be raised on the right of Great Britain to exclude all together vessels of the United States from trading with British ports situated upon the St. Lawrence or elsewhere in Canada? I replied that I was not prepared to deny absolutely such a right in Great Britain, to whatever

considerations its exercise might be opened. I remarked also that it seemed already to have been substantially exercised by the act of August 5, 1822; for, by its provisions, only certain enumerated articles were allowed to be exported from the United States to Canadian ports, and the duties were laid upon these articles which might be said to amount to a pro-I added that although the foregoing act had not laid any duty on the merchandise of the United States descending the St. Lawrence, with a view to exportation by the sea, yet that an act of the preceding year did, viz., upon their timber and lumber which made it highly expedient that the relative rights of the parties to the use of the waters of this great stream should be ascertained.

"I approach the interesting part of this negotiation where I come to make known in what manner the British received this disclosure. They said that, on principles of accommodation they were willing to treat of this claim with the United States in a spirit of entire amity; that is, as they explained it, to treat of it as a concession on the part of Great Britain for which the United States must be prepared to offer a full This was the only light in which they could enequivalent. tertain the question. As to the claim of right, they hoped that it would not even be advanced; persisted in, they were willing to persuade themselves it would never be. It is equally novel and extraordinary. They could not repress their strong feelings of surprise at its bare intimation. Britain possessed, absolutely, sovereignty over the river, in all its parts, where both its banks were of her territorial dominion. Her right hence to exclude a foreign nation from navigating it was not to be doubted, scarcely to be discussed. That was the manner in which it was at first received. They opposed to the claim an immediate positive and unqualified resistance."

"I said that our claim was one that had been well considered by my government and was believed to be maintainable on the soundest principles of public law. The question had been familiar to the past discussions of the United States, as the state papers, which were before the world, would show. It had been asserted and successfully asserted in relation to another great river of the American continent flowing south, the Mississippi, at a time when both of its lower banks were under the dominion of a foreign power. The essential principles that had governed one case were now applicable to the

other."

"My reply was not satisfactory to the British. They combated the claim with increased earnestness, declaring it was altogether untenable and of a nature to be totally and unequivocally rejected. Instead of having the sanction of public law, the law and the practice of nations equally disclaimed it. Could I show where was to be found, in either, the least warrant for its assertion? Was it not a claim plainly inconsistent with the paramount authority and exclusive possession of Great Britain? Could she for one moment listen to

"The necessity of my recounting to you the British argument in answer to our claim is superseded by my being able to transmit it to you in their own words upon paper. It is sufficiently elaborate, and is drawn up with great deliberation. It is annexed (marked 'N') to the protocol of the 24th Conference. The intention avowed by the British at the 19th Conference of obtaining for its doctrines, before its delivery to me, the full sanction of their highest professional authorities on matters relating to the law of nations may serve to show the gravity and the importance which the question had assumed in their eyes. Their argument was prepared under the advice and assistance of five of the most eminent publicists of England.

N.

BRITISH PAPER ON THE NAVIGATION OF THE ST. LAWRENCE—24TH PROTOCOL. Aug. 12, 1824.

The claim of the United States to the free navigation of the river St. Lawrence wears a character of peculiar impor-

tance when urged as an independent right.

The American Plenipotentiary must be aware that a demand, rested upon this principle, necessarily precludes those considerations of good neighborhood and mutual accommodation, with which the Government of Great Britain would otherwise have been anxious to enter upon the adjustment of this part of the negotiation.

A right claimed without qualification on the one side, affords no room for friendly concession on the other; total admission, or total rejection, is the only alternative which it

presents.

On looking to the objects embraced by the American claim, we find them to be of no ordinary magnitude. The United States pretend to no less than the perpetual enjoyment of a free, uninterrupted passage, independent of the territorial avereign, through a large and very important part of the British possessions in North America. They demand, as their

necessary inherent right, the liberty of navigating the St. Lawrence from its source to the sea, though, in the latter part of its course, which lies entirely within the British dominions, and comprises a space of nearly six hundred miles, that river traverses the finest settlements of Canada, communicates by the south with Lake Champlain, and washes the quays of Montreal and Quebec.

A pretension which thus goes to establish a perpetual thoroughfare for the inhabitants, vessels, and productions, of a foreign country through the heart of a British colony, and under the walls of its principal fortress, has need to be substantiated on the clearest and most indisputable grounds. It requires, indeed, an enlarged view of what is owed in courtesy by one nation to another to justify the British Government in entering, at this late period, on the discussion of so

novel and extensive a claim.

There will, however, be little difficulty in showing that the claim asserted by the American Plenipotentiary rests, as to any foundtation of natural right, on an incorrect application of the authorities which he has consulted. With respect to the claim derived from an acquired title which he has also alleged, that ground of claim will remain to be examined hereafter; but it may be observed, in the outset, that the natural and acquired title depend on principles essentially distinct; that the one cannot be used to make good any defect in the other; and although they may be possessed independently by the same claimant, that they can, in no degree, con-

tribute to each other's validity.

Proceeding to consider how far the claim of the United States may be established on either of these titles, it is first necessary to inquire what must be intended by the assertion that their claim is founded on natural right. "The right of navigating this river," says the American Plenipotentiary, "is a right of nature, pre-existent in point of time, not necessary to have been surrendered up for any purpose of common good, and unsusceptible of annihilation." The right here described, can be of no other than of that kind which is generally designated in the law of nations a perfect right. Now, a perfect right is that which exists independent of treaty; which necessarily arises from the law of nature; which is common, or may, under similar circumstances, be common to all independent nations; and can never be denied or infringed, by any State, without a breach of the law of nations. Such is the right to navigate the ocean without molestation in time of peace.

Upon these principles, now universally received, it is contended for the United States that a nation possessing both shores of a navigable river at its mouth, has no right to refuse the passage of it to another possessing a part of its upper banks, and standing in need of it as a convenient channel of commercial communication with the sea. Applying the same principles to the case of the St. Lawrence, the American Government maintain that Great Britain would be no more justified in controlling American navigation on that river, than in assuming to itself a similar right of interference on the high seas.

To this extent must the assumption of a perfect right be carried, or such claim is no longer to be considered in that character; but falling under the denomination of an imperfect right, it becomes subject to considerations essentially and

entirely different.

The first question, therefore, to be resolved is, whether a perfect right to the free navigation of the river St. Lawrence can be maintained according to the principles and prac-

tice of the law of nations.

Referring to the most eminent writers on that subject, we find that any liberty of passage to be enjoyed by one nation through the dominions of another, is treated by them as a qualified occasional exception to the paramount rights of property. "The right of passage," says Vattel, "is also a remainder of the primitive communion in which the entire earth was common to men, and the passage was everywhere free according to their necessities." Grotius, in like manner, describes mankind as having, in their primitive state, enjoyed the earth and its various productions in common, until after the introduction of property, together with its laws, by a diversion or gradual occupation of the general domain. Among the natural rights, which he describes as having in part survived this new order of things, are those of necessity and of innocent utility; under the latter of which he classes the right of passage. Following his principle, this natural right of passage between nation and nation may be compared to the right of highway, as it exists, in particular communities, between the public at large and the individual proprietors of the soil, but with this important difference, that, in the former case, commanding and indispensable considerations of national safety, national welfare, and national honor and interest, must be taken especially into the account.

It is clear that, on this principle, there is no distinction between the right of passage by the river flowing from the possessions of one nation, through those of another, to the ocean, and the same right to be enjoyed by means of any highway, whether of land or of water, generally accessible to the inhabitants of the earth. "Rivers," says Grotius, "are subject to property, though neither where they rise, nor where they discharge themselves, be within our Territory." The right to exclusive sovereignty over rivers, is also distinctly asserted by Bynkershock, in the ninth chapter of his treatise "on the dominion of the sea." Nor is this, by any means, the full latitude to which the principle, if applied at all, must, in fairness, be extended. "All nations," says Vattel, "have a general right to the innocent use of the things which are under any one's domain." "Property," says the same author, "cannot deprive nations of the general right of traveling over the earth, in order to have communications with each other, for carrying on trade, and other just reasons." The nature of these other just reasons is explained by Grotius, in the following sentence: "A passage ought to be granted to persons, whenever just occasion shall require, over any lands or rivers or such parts of the sea as belongs to any nation, as for instance, if, being expelled from their own country, they want to settle in some uninhabited land, or if they are going to traffic with some distant people, or to recover, by a just war, what is their own right and due."

For other purposes then, besides those of trade, for objects of war, as well as for objects of peace, for all nations, no less than for any nation in particular, does the right of passage hold good under those authorities to which the American Plenipotentiary has appealed. It has already been shown that, with reference to this right, no distinction is drawn by them between land and water, and still less between one sort of river and another. It further appears, from Vattel, that the right in question, particularly, for the conveyance of merchandise, is attached to artificial, as well as to natural, highways. "If this passage," he observes, "occasion any inconvenience, any expense" for the preservation of canals and highways, it may be recompensed "by rights of toll."

Is it then to be imagined that the American Government can mean to insist on a demand, involving such consequences, without being prepared to apply, by reciprocity, the principle on which it rests in favor of Great Britain? Though the sources of the Mississippi are now ascertained to lie within the territory of the United States, the day cannot be distant when the inhabitants of Upper Canada will find convenience in exporting their superfluous produce by means of the chan-

nel of that river to the ocean. A few miles of transport over land are of little consequence, when leading to a navigable river of such extent. Even at the present time, a glance upon the map is sufficient to show that the course of the Hudson, connected as it now is with the waters of the St. Lawrence, would afford a very commodious outlet for the produce of the Canadian provinces. The comparative shortness of this passage, especially with reference to the West Indies, would

amply compensate for any fair expense of tolls.

It would also be, in some instances, convenient and profitable for British vessels to ascend the principal rivers of the United States, as far as their draft of water would admit, instead of depositing their merchandise, as now, at the appointed ports of entry from the sea. Nor is it probable that other nations would be more backward than the British in pressing their claim to a full participation in this advantage. The general principle which they would invoke, in pursuance of the example given by America, and a partial application of such principles no country can have a right to expect from another, is clearly of a nature to authorize the most extraordinary and unheard of demands. As for the right of passage from sea to sea, across any intervening isthmus, such, for instance, as that of Corinth or of Suez, and, more especially, from the Atlantic to the Pacific, by the Isthmus of Panama, that right of passage follows as immediately from this principle, as any such right claimed from one tract of land to another, or to the ocean, by water communication.

The exercise of a right, which thus goes the length of opening a way for foreigners into the bosom of every country, must necessarily be attended with inconvenience, and sometimes with alarm and peril, to the State whose territories are to be traversed. This consequence has not been overlooked by writers on the law of nations. They have felt the necessity of controlling the operation of so dangerous a principle, by restricting the right of transit to purposes of innocent utility, and by attributing to the local sovereign the exclusive power of judging under what circumstances the passage through his dominion is, or is not, to be regarded as innocent. In other words, the right which they have described is, at

best, only an imperfect right.

It is under the head of innocent utility, that Grotius has classed the right of passage, as before laid down in his own expressions.

"Innocent utility," he adds, "is when I only seek my own advantage, without damaging anybody else." In treating of

the same right, Vattel remarks that, "since the introduction of domain and property, we can not otherwise make use of it, than by respecting the proper right of others." "The effect," he adds, "of property, is to make the advantage of the

proprietor prevail over that of all others."

The same author defines the right of innocent use, or innocent utility, to be "the right we have to that use which may be drawn from things belonging to another, without causing him either loss or inconvenience." He goes on to say, that "this right of innocent use is not a perfect right like that of necessity: for it belongs to the master to judge if the use we would make of a thing that belongs to him, will be

attended with no damage or inconvenience."

With respect to the assertion of Grotius, as quoted by the American Plenipotentiary, "that the mere apprehension of receiving injury from the exercise of this right, is not a sufficient reason for denying it," the author, it must be observed, is addressing himself to the conscience of the Sovereign through whose territories a passage may be demanded; impressing upon his mind that he cannot fully discharge his moral obligations in giving such refusal, unless he be well convinced that his fears originate in just causes. But it would be absurd, and contrary to the general tenor of his argument, to suppose, that a well founded apprehension was not to have its due effect, or that the advantage, or even necessity, of a foreign nation could be justly recognized by him as paramount, in the one case, to the leading interests, in the other, to the safety, of his own.

It is further to be observed, that Grotius, in the argument referred to, had clearly in view an occasional liberty of passage, not of that perpetual, uninterrupted kind, which the regular activity of modern commerce requires. But the doctrine of Grotius, applied to merchandise, and taken in the

regular activity of modern commerce requires. But the doctrine of Grotius, applied to merchandise, and taken in the sense ascribed to it by the American Plenipotentiary, is distinctly contradicted by other eminent writers on the law of nations. Puffendorf, for instance, in his great work on that subject, expresses himself as follows: "We may have good reasons for stopping foreign merchandise, as well by land as on a river, or on an arm of the sea, within our dependence. For besides that a too great affluence of foreigners is sometimes prejudicial or suspicious to a State, why should not a Sovereign secure to his own subjects the profit made by foreigners, under favor of the passage which he allows them?" "I admit, that in allowing foreigners to carry their merchandise elsewhere, even without paying for the passage, we do

not sustain any damage, and that they do us no wrong in pretending to an advantage of which we might have possessed ourselves before them. But, at the same time, as they have no right to exclude us from it, why should we not try to draw it to ourselves? Why should we not prefer our interest to theirs?"

The same author observes, in the next section of his work, "that a State may fairly lay a duty on foreign goods conveyed through its territory, by way of compensation for what its subjects lose by admitting a new competitor into the

market."

To appreciate the full force of these opinions, it must be borne in mind that Puffendorf appears to speak of a foreign nation so situated as to depend exclusively on the passage in question for the sale of its superfluous produce, and the importation of supplies from abroad. This part of the subject may be closed with the following decisive words of Barbeyrac, in his Notes on Grotius: "It necessarily follows from the right of property, that the proprietor may refuse another the use of his goods. Humanity, indeed, requires that he should grant that use to those who stand in need of it, when it can be done without any considerable inconvenience to himself; and, if he even then refuses it, though he transgresses his duty, he doth them no wrong, properly so called, except they are in extreme necessity, which is superior to all ordinary rules."

But the American Plenipotentiary maintains that the right of passage, as understood by him in opposition to his own authorities, that is, independent of the Sovereign's consent, and applied to the single predicament of the St. Lawrence, has been substantially recognized by the Powers of Europe, in the treaties of general pacification, concluded at Paris in

1814, and in the following year at Vienna.

It is true that, in the solemn engagements then contracted by them, the Sovereigns of the leading States of Europe manifested a disposition to facilitate commercial intercourse between their respective countries, by opening the navigation of such of the principal rivers as separated or traversed the territories of several Powers. This policy was applied more particularly to the Rhine, the Necker, the Maine, the Moselle, the Maese, and the Scheldt. But neither in the general, nor in the special stipulations, relating to the free navigation of rivers, is there anything to countenance the principle of a natural, independent right, as asserted by the American Plenipotentiary. We find, on the contrary, that, in the treaty concluded at Paris, between France and the Allied Powers, the

Rhine was the only river at once thrown open to general navigation. With respect to the other rivers, it was merely stipulated that the means of extending that arrangement to them should be determined by the Congress about to assemble at Vienna. In the instance of the Rhine, it was natural for France, in giving up possessions which she had for some time enjoyed on the banks of that river, to stipulate a reserve of the navigation. The stipulations relating to river navigation, in the general treaty of Vienna, commence in the following manner: "The Powers whose States are separated or crossed by the same navigable river, engage to regulate by common consent, all that regards its navigation." They close with an agreement that the regulations, once adopted, shall not be changed, except with the consent of all the Powers

bordering on the same river.

It is evident, therefore, that the allied Governments, in concurring to favor the circulation of trade through the great water communications of continental Europe, did not lose sight of what was due to the sovereignty of particular States; and that, when they referred the common enjoyment of certain navigable rivers to voluntary compact between the parties more immediately concerned, they virtually acknowledged the right of any one of those parties, till bound by its own engagements, to withhold the passage, through its dominions, from foreign merchant vessels. As freedom of navigation in favor of all nations, and not merely of those which border on the rivers thus opened by treaty, was the immediate object of the above mentioned stipulations, it must be presumed that the Powers assembled in Congress, if they had felt themselves borne out by the practice or general opinion of Europe, would not have hesitated to proclaim the measure which they adopted as one of natural independent right. Their silence alone on this point might have been taken as strongly indicative of their belief that the prevailing usage of Europe would authorize no such declaration. But the principle of mutual consent is surely irreconcilable with the contrary supposition, and must, at least, be understood to give a special character to the engagements contracted under it, confining them to the rivers enumerated in the treaty; and, however laudable, as an example to other States, whose circumstances may allow of their imitating it without danger or detriment, expressive of no obligation beyond the occasion for which the treaty was framed.

It would take up too much time to demonstrate by a detailed investigation of every case to which the American argument applies, the negative proposition that no nation exercises the liberty of navigating a river, through the territories of another, except by permission or express concession under treaty. It is rather for the American Government to present a single instance in which the liberty claimed for the United States is exercised explicitly as a natural inde-

pendent right.

The case of the Scheldt, though referred to by the American Plenipotentiary, is certainly not one of this kind. The leading circumstances relating to that river were, first, that its mouths, including the canals of Sas and Swin, lay within the Dutch Territory, while parts of its upper channel were situate within the Flemish provinces. Secondly, That the treaty of Westphalia had confirmed the right of the Dutch to close the mouths of the river. Thirdly, That the exercise of this right was disputed, after a lapse of more than a hundred years, by the Emperor of Germany; and, fourthly, that the dispute between that monarch and the Dutch Republic terminated, in 1785, by leaving the Dutch in possession of the right which had been disputed. It is true, that, at the latter period, the Dutch founded their claim, in part, on the expense and labor which they had undergone in improving the river; but, it is true at the same time, that they also grounded it on the general law of nations. Above all, they rested it on the treaty of Westphalia. But if the right of the Dutch Republic had been countenanced by the law and practice of nations, why, it may be asked, should it have been thought necessary to confirm that right by the treaty of Westphalia? The reply is obvious, that confirmation was the resort of the weak against the strong: of the former dependents of Spain against the encroachments of a haughty power, still sovereign of Antwerp, and the neighboring provinces, and not having yet renounced its claim of sovereignty over Holland itself. It was natural for the Dutch, under such circumstances, to fortify their right by the general sanction of Europe; but it was not natural for the principal parties in the pacification of Munster, to lend their sanction to a measure in direct contradiction to acknowledged principles; or, if their scruples, as to the admission of such a measure, had been removed by special motives, it is strange that they should not have taken the obvious precaution of recording those motives. During the discussions about the Scheldt, in 1785, the Empress of Russia was the only Sovereign who officially declared an opinion in favor of the House of Austria. But the United States can derive no great advantage from a declaration couched in such

terms as these: "Nature herself hath granted to the Austrian Low Countries the use and advantage of the river in dispute: Austria alone, by virtue of the law of nature and nations, is entitled to an exclusive right to the river in question. So that the equity and disinterestedness of Joseph II, can only impart this right to other people—it belonging exclusively to his States."

The opinions proclaimed on this subject by the Russian Government are the more remarkable, as there is no country which has a greater interest than Russia in the disputed questions. It is well known, that the only approach to the Russian ports on the Black Sea, from the Mediterranean and Atlantic, is by the passages of the Dardanelles and Bosphorus. These canals are, in fact, salt-water straits, communicating from sea to sea; passing, it is true, between the Turkish territories in Europe and Asia, but with no great length of course, and leading to a vast expanse of inland water, the shores of which are occupied by no less than three independent Powers.

There is manifestly a wide difference between such a case and that of the St. Lawrence, nor can the marked difference in principle between rivers and straits be overlooked; and yet, as matter of fact, the navigation of the Black Sea, and the adjacent canals is enjoyed by Russia—by that Power which has so often dictated its own conditions to the Porte—in virtue of a treaty, founded, like other treaties, on the mutual convenience and mutual advantage of the parties. Even the navigation of the Danube, downwards to the ocean, was first accorded to Austria by the Turkish Government, as a specific concession made at a juncture when the Porte, involved in a quarrel with the most formidable of its neighbors, was compelled to propitiate the good will of other Christian Powers.

The case of the Mississippi is far from presenting an exception to this view of the subject. The treaty of 1763, which opened the navigation of that river to British subjects, was concluded after a war in which Great Britain had been eminently successful. The same motives that prevailed with France to cede Canada, must have restrained her from hazarding a continuance of hostilities for such an object as the exclusive navigation of the Mississippi. The agreement respecting that river makes part of the general provisions as to the western boundary of the British possessions in America, by which the whole left side of the Mississippi was ceded to

Great Britain, with the exception of the town and island of New Orleans. This reservation was admitted on the express condition, that the navigation of the whole channel should be open to British subjects. The very fact of its having been thought necessary to insert this stipulation in the treaty, in consequence of France having retained possession of both banks of the river, at a single spot, leads irresistibly to an inference the very reverse of what is maintained by the

American Plenipotentiary.

At a later period, the navigation of the Mississippi became subject of arrangement between Spain and the United States. By the fourth article of their treaty of boundary and navigation, concluded in 1795, a similar agreement to that which had before subsisted between France and Great Britain, was effected between those Powers, with this remarkable difference, that the liberty of navigating the river was expressly confined to the parties themselves, unless the "King of Spain", to use the words of the treaty, "should extend the privilege to the subjects of other Powers by special convention."

It must not be overlooked, that, when the clause which is here quoted, and the exclusive stipulation immediately preceding it, were drawn up, the sources of the Mississippi were still supposed to be within the British territory; and at the same time, there was in force a treaty between Great Britain and the United States, declaring that "the navigation of the river Mississippi, from its source to the ocean, should, forever, remain free and open to the subjects of Great Britain."

Some additional light may, perhaps, be thrown on the object of the present discussion, by the quotation of a note on the fourth article of the Spanish treaty, which is printed in the collection of the United States' laws, arranged and published under the authority of an act of Congress. It is as

follows:

"Whatsoever right his Catholic Majesty had to interdict the free navigation of the Mississippi, to any nation, at the date of the treaty of San Lorenzo el Real, (the 27th of October, 1795,) that right was wholly transferred to the United States, in virtue of the cession of Louisiana from France, by the treaty of April 30th, 1808. And, as the definitive treaty of peace was concluded previously to the transfer to the United States of the right of Spain to the dominion of the river Mississippi, and, of ourse, prior to the United States' possessing the Spanish right, it would seem that the stipulation contained in the 8th

article of the definitive treaty with Great Britain, could not have included any greater latitude of navigation on the Mississippi, than that which the United States were authorized to grant on the 3d of September, 1783."

"The additional right of sovereignty which was acquired over the river by the cession of Louisiana, was paid for by the American Government; and therefore any extension of it to a Foreign power could scarcely be

expected without an equivalent."

The natural right asserted by the American Plenipotentiary being thus examined in respect both to the principles which it involves, and to the general practice of nations, the acquired title, as distinct from the natural, stands next for

consideration.

This title is described in the American argument, as originating in circumstances which either preceded or attended the acquisition of the Canadas by Great Britain. It is said, "that, if Great Britain possessed the navigation of the St. Lawrence before the conclusion of peace in 1763, so did the People of the United States, as forming, at that time, a part of the British empire; but if Great Britain only first acquired it together with the Canadas, then did the People of the United States acquire it common with her at the same period." In both the supposed cases, it is taken for granted, that whatever liberty to navigate the St. Lawrence, in the whole length of its course, the inhabitants of the United States enjoyed when those States were part of the British Empire, continued to belong to them after their separation from the Mother country. Now, if this were so it would also be true, and in a far stronger degree, that the subjects of Great Britain have an equal right to enjoy, in common with American citizens, the use of the navigable rivers and other public possessions of the United States, which existed when both countries were united under the same Government. For the acquired title, be it remembered, does not affect the St. Lawrence, as a river flowing from the territories of one Power, through those of another, to the sea, but is manifestly grounded on the supposition that an object which had been possessed in common by the People of both countries, up to the time of their separation, continues to belong in point of use, to both, after they have ceased to be parts of the same community. If it be true, that the inhabitants of the United States contributed as British subjects, to effect the conquest of Canada, it cannot, at the same time, be denied, that the United States, before their separation from Great Britain, were frequently indebted to the councils and exertions of the parent country for protection against their unquiet and encroaching neigh-

bors.

Specifically did they owe to Great Britain their first enjoyment of the waters of the Mississippi, conquered in part from France by the very same efforts which transformed Canada from a French settlement into a British Colony. The pretension of the American Government as grounded on the simultaneous acquisition of the St. Lawrence, as well by the inhabitants of the adjacent, and, at that time, British Provinces, as by those of the countries originally composing the British monarchy, must, therefore, if admitted even for the sake of argument, be applied reciprocally in favor of Great Britain.

The fact, however, is, that no such pretension can be allowed to have survived the treaty by which the independence of the United States was first acknowledged by Great

Britain.

By that treaty a perpetual line of demarcation was drawn between the two Powers, no longer connected by any other ties than those of amity and conventional agreement.

No portion of the sovereignty of the British empire, exclusive to the actual territory of the United States, as acknowledged by that treaty, could possibly devolve upon the People of the United States, separated from Great Britain.

By the same instrument, the territorial boundary of the States, as recognized by their former sovereign, were carefully defined, for the express purpose of avoiding disputes in future; and the articles stipulating for a concurrent enjoyment of the North American fisheries, and of the navigation of the river Mississippi, prove that equal care was taken to determine, in the general act of pacification and acknowledgment, those objects, of which the usufruct in common was either retained or conceded by Great Britain.

Is it conceivable, under these circumstances, that the treaty of 1783, should have made no mention of the concurrent navigation of the St. Lawrence, if the claim, now raised by the

United States, had rested on any tenable grounds?

But the commercial treaty of 1794, would afford additional proof, if it were wanted, that the channel of the St. Lawrence, from the sea to the 45th parallel of latitude, was never for a moment considered as forming any exception to the territorial possessions of Great Britain.

The third article of the commercial treaty shows, most

clearly, that the power of excluding foreign vessels from those parts of the river which flow entirely within the British dominions, was deemed to belong of right to the British Government. The leading purpose of that article is, to establish a free commercial intercourse between the two parties throughout their respective territories in North America.

The same article contains a limitation of this privilege with respect to a considerable portion of the St. Lawrence, to which it was declared that American vessels were not to have access; and the corresponding restriction against Great Britain, was an exclusion of British vessels from such parts of the rivers of the United States as lie above the highest

ports of entry for foreign shipping from the sea.

It necessarily results, from the nature of the two clauses thus viewed with reference to each other, that the authority of Great Britain over the part of the St. Lawrence interdicted to American vessels, was no less completely exclusive, that that of the United States over such parts of their interior waters as were, in like manner, interdicted to the shipping of Great Britain.

The former limitation is, besides, of itself inconsistent with the notion of a right to a free uninterrupted passage for

American vessels, by the St. Lawrence, to the ocean.

Nor is it less conclusive as to the merits of the case, when coupled with the declaration contained in the very same article, that the navigation of the Mississippi was to be enjoyed in common by both parties, notwithstanding that a subsequent article of the same treaty expresses the uncertainty which already prevailed with respect to the sources of that river being actually situated within the British frontiers.

With these facts in view, it is difficult to conceive how a tacit enjoyment of the navigation now claimed, can be stated by the American Plenipotentiary to account for the silence maintained on this subject by his Government, from the establishment of its independence to the present negotiation.

In the course of forty years, during which no mention whatever has been made of this claim, there has been no want of opportunities fit for its assertion and discussion. To say nothing of periods, anterior to the rupture of 1812, it is strange that an interest of such vast importance should have been wholly neglected, as well on the renewal of peace, in 1815, as during the negotiation of the commercial treaty which took place in the close of that year. This long continued silence is the more remarkable as the mere apprehension of an eventual change in the regulations, under which a part of the St. Lawrence is actually navigated by foreign vessels, has been alleged by the American Government as

their reason for now raising the discussion.

The regions contiguous to the upper waters of the St. Lawrence are doubtless more extensively settled than they were before the late war, and the inhabitants of those regions might at times find it advantageous to export their lumber and flour by the channel of that river. But mere convenience, and the profits of trade, cannot be deemed to constitute that case of extreme necessity under the law of nations, to which the rights of property may perhaps be occasionally required to give way. It has already been shown, that such interests can, at most, amount to an imperfect right of innocent utility, the exercise of which is entirely dependent on the will and discretion of the local sovereign. Of this description are the rights and accompanying duties of nations to trade with each other, and to permit the access of foreigners to their respective waters in time of peace; but will any one, at the same time, call in question the co-existing right of every State, not only to regulate and to limit its commercial intercourse with others, but even, as occasion may require, to suspend or to withhold it altogether?

If ever there was a case, which particularly imposed on a sovereign the indispensable duty of maintaining this right unimpaired, even with every disposition to consult the convenience and fair advantage of friendly nations, it is the

present unqualified demand of the United States.

It cannot be necessary to enumerate the various circumstances which make this claim peculiarly objectionable; but there is no concealing, that, besides the ordinary considerations of territorial protection, those of commercial interest and colonial policy are alike involved in the demand of a free gratuitous, unlimited right of passage for American citizens, with their vessels and merchandise, from one end of Canada to the other.

Interests of such high national importance are not to be put in competition with the claims of justice; but when justice is clearly on their side, they have a right to be heard, and cannot be denied their full weight. That the right is, in this instance, undoubtedly on the side of Great Britain, a moment's reflection on the preceding argument will suffice to estab-

It has been shown that the independent right asserted by

the United States, is inconsistent with the dominion paramount sovereignty and exclusive possession of Great Britain.

It has been proved, by reference to the most esteemed authorities on the law of nations, with respect as well to the general principle as to the opinions distinctly given on this point, that the right of sovereignty and exclusive possession extends over rivers, in common with the territory through which they flow.

The same principles and the same opinions have been cited to prove that those parts of the river St. Lawrence which flow exclusively through the British dominions, form no exception

to the general doctrine so applied to rivers.

The existence of any necessity calculated to give the United States, in this case, a special right, in contradiction to the general rule, has been distinctly denied, and the denial con-

clusively supported by a reference to known facts.

With no disposition to contest such imperfect claims and moral obligations, as are consistent with the paramount rights of sovereignty and exclusive possession, it has been proved, from the authorities already quoted, that of those imperfect claims and moral obligations, the territorial sovereign is the judge.

The title of the United States, as derived from previous enjoyment at the time when they formed part of the British empire, has been shown to have ceased with the conclusion of that treaty by which Great Britain recognized them in the

new character of an independent nation.

It has also been shown, that, while the American government acknowledge that their claim is now brought forward for the first time, not only have they had, since their independence, no enjoyment, under treaty, of the navigation now claimed, but that the provisions of the commercial treaty, concluded in 1794, and described as having been till lately in force, are in direct contradiction with their present demand.

It has finally been made to appear, that the treaties concluded by European Powers, as to the navigation of rivers, far from invalidating the rights of sovereignty in that particular, tend, on the contrary, to establish those rights; and that the general principle of protection, essential to sovereignty, dominion, and property, applies with peculiar force to the present case of the river St. Lawrence.

EXTRACT OF LETTER FROM MR. GALLATIN TO MR. CLAY, DE-CEMBER 21, 1827.

"The British plenipotentiary will not entertain any proposition respecting the navigation of the St. Lawrence founded on the right claimed by the United States to navigate that river at the sea."

EXTRACT OF LETTER FROM MR. GALLATIN TO MR. CLAY, Ocтовев 1, 1827.

"The British plenipotentiary reply that however well disposed Great Britain might be to treat with the United States respecting the free navigation of the St. Lawrence as a question of mutual convenience, yet the views of the British government, being the same now as they were in 1824, and they being prohibited by express instructions from entering into any discussion respecting the free navigation of the river, if claimed as heretofore by the United States on the ground of right, they could not entertain any proposition to that effect if now made by

me.

In an interview I had with Lord Dudley, after having expressed regrets that no arrangement could be made at this time on the subject, and after having urged the other reasons which should induce Great Britain no longer to prevent navigation of American boats and vessels between Montreal and Quebec, and that if she persisted in denying it, which although I had no authority to say such was the intention of my government, yet, it seemed a natural consequence, and ought not to be considered as giving offense, that the United States should adopt corresponding measures in regard to the navigation of the river St. Lawrence within their own limits. Lord Dudley, who appeared to acquiesce in my general remarks, made no observation on the last suggestion."

ACT OF JANUARY 9, 1836.

An Act for the Construction of the Illinois and Michigan Canal.

(GOVERNOR AUTHORIZED TO NEGOTIATE A LOAN ON THE FAITH OF THE STATE.)

Section 1. Be it enacted by the People of the State of Illinois, represented in the General Assembly: That the Governor of this State be, and he is hereby authorized and empowered to negotiate a loan on the credit and faith of this State, as hereinafter provided for the purpose of aiding in connection with such other means as may be hereafter received from the government of the United States, in the construction of the Illinois and Michigan canal, a sum not exceeding five hundred thousand dollars, which shall be required to be paid at such times and by installments as the same may be needed in the progress of the said work, as near as the same can be estimated.

SEC. 2. (CERTIFICATES OF STOCK—FAITH OF THE STATE PLEDGED.) The Governor shall cause to be constituted certificates of stock for the said loan, to be called the "Illinois and Michigan Canal Stock" signed by the auditor and countersigned by the treasurer, bearing an interest not exceeding six per cent per annum, payable semi-annually at the Bank of the State of Illinois or any of its branches, or at some bank in the cities of New York, Philadelphia, Boston, or either, as may be agreed upon and reimbursable at the pleasure of the State, at any time after the year one thousand, eight hundred and sixty, and the faith of the State is hereby irrevocably pledged for the payment of the stock hereby created and the interest accruing thereon.

SEC. 3. (Transferring of stock.) The Governor shall take and use all proper means and measures for the transferring

of the said stock.

SEC. 4. (CERTIFICATES OF STOCK TO BE SOLD.) It shall be deemed a good execution of the said power, to borrow, for the Governor to cause the said certificates of stock, when created, to be sold; provided, that the said stock shall not in any case be sold for less than its par value.

SEC. 5. (MONIES TO BE DEPOSITED IN THE BANK AT INTEREST.) It shall be the duty of the Governor to cause the said monies from time to time, when paid or advanced, to be deposited in some safe bank or banks until wanted for use, at the best in-

terest that can be obtained for it, to be drawn out as hereinafter provided, taking therefor the proper securities for the

safekeeping of the same.

(WHAT CONSTITUTES CANAL FUND-PROVISO.) The SEC. 6. money thus loaned, the premiums arising from the sale of any stock thus created, the proceeds of the canal lands and town lots, and all of the monies in any way arising from the contemplated canal shall constitute the canal fund, and shall be used for canal purposes and for no other whatever, until the said canal shall have been completed; provided, that nothing herein contained shall be so construed as to prevent appropriations from being made out of the said fund for semi-annual payment of the interest upon the canal stock herein authorized to be created, and the Governor is hereby authorized to cause the said interest to be paid out of the said fund.

SEC. 7. (GOVERNOR TO APPOINT BOARD-VACANCY, HOW FULLED.) The Governor of this State by and with the advice of the Senate, shall appoint three practical and skillful citizens of this State to constitute a board, to be known by the style and description of "The Board of Commissioners of the Illinois and Michigan Canal," and he shall designate one of said commissioners to be president thereof, one to be treasurer and one to be acting commissioner; whenever any vacancy shall occur in the said board of commissioners by death, resignation or from any other cause the Governor of this State shall fill such vacancy during the recess of the legislature, and the Governor shall have power to remove from office any canal commissioner for good cause which he shall make known in a communication to the next ensuing General Assembly.

SEC. 8. (TERM OF SERVICE.) The board of commissioners to be appointed as aforesaid shall hold their office until the first Monday in January, 1837, and thereafter the said board of commissioners shall be biennially appointed in such manner as

the legislature may from time to time direct.

SEC. 9. (SALARY.) The acting commissions The acting commissioner shall be allowed a salary of twelve hundred dollars per annum, and the rest of the board shall each be allowed a compensation of three dollars per day while necessarily employed in the busi-

ness of the canal.

SEC. 10. (INCORPORATED.) The said board of commissioners is hereby constituted a body politic and corporate with full power and authority in their corporate name to contract and be contracted with, sue and be sued, defend and be defended, plead and be impleaded, in all matters and things relating to them as canal commissioners, and they shall have and use a common seal of such device as the Governor may direct.

SEC. 11. (TO APPOINT A SECRETARY.) The board shall appoint a secretary, whose duty it shall be to keep a true record of all their proceedings; they shall hold quarter yearly meetings, and special meetings whenever any two of them or the acting commissioner may desire it, any two of them shall con-

stitute a quorum to do business.

Sec. 12. (Commissioners to be sworn—proviso.) Before entering upon the duties of their office each of the said commissioners shall make oath or affirmation, faithfully, honestly and truly to execute and discharge all the duties and obligations herein imposed upon them, and each of them as canal commissioners and they shall severally give bonds to the Governor and his successors, in office for the use of the State, in the sum of ten thousand dollars with sufficient securities, for the faithful discharge of the duties imposed upon them by this Act; provided, that the Governor may at any time require additional bonds of said treasurer, whenever he may think that the safety of the funds require it.

Sec. 13. (When money due treasurer may draw check on bank.) Whenever all or any part of the money upon any contract shall become due, it shall be the duty of the treasurer to draw his warrant or check, therefore, in favor of the contractor upon the bank or banks in which the canal fund shall have been deposited, which warrant or check, shall be countersigned by the acting commissioner and shall be under the

seal of the board.

Sec. 14. (Commissioners to obtain a quantity report from bank and lay it before board.) It shall be the duty of the acting commissioner to obtain from the cashier of the bank or banks, in which the said fund shall have been deposited, a quarterly report, exhibiting a true account of all monies received in deposit on account of the canal fund and paid out of the said fund during the previous quarter, which report shall be laid before the board of canal commissioners, and within twenty days thereafter, shall be examined by the said board and compared with the accounts of the treasurer and an entry shall be made in the books of the said board that the said examination has been made by them, and that the two accounts correspond, if such be the case, by each commissioner present shall sign his name to the record of such examination.

SEC. 15. (COMMISSIONERS TO CONTRACT FOR MATERIALS AND LABOR—CONDUCT OF ALL OFFICERS—TO ENFORCE DUTIES—TO EX-

AMINE STATE OF CANAL AND HAVE SUPERINTENDENCE THEREOF.) It shall be the duty of the acting commissioner:

1st .- To make under the direction of the board, all necessary contracts for the material and the performance of labor.

2nd .- To inquire into the official conduct of the agents, clerks, superintendents and all subordinate officers and to receive and hear all complaints that may be preferred against them.

3rd .- To enforce the faithful execution by all persons concerned, of the duties and obligations imposed upon them by

this Act.

4th .- To examine frequently and carefully, into the state of

the canal and the progress of the works thereon.

5th.—To have the immediate care and superintendence of

the canal and all matters relating thereto.

SEC. 16. (DESCRIPTION-PROVISO.) The said canal shall not be less than forty-five feet wide at the surface, thirty feet at the base and of sufficient depth to insure a navigation of at least four feet, to be suitable for ordinary canal boat navigation, to be supplied with water from Lake Michigan and such other sources as the canal commissioners may think proper, and to be constructed in the manner best calculated to promote the permanent interest of the country; reserving ninety feet on each side of said canal, to enlarge its capacity, whenever in the opinion of the board of canal commissioners, the public good shall require it; provided, that all persons who have purchased, or shall hereafter purchase lands fronting the said canal shall be permitted to lease from the said board the said reserved ground on each side of said canal, from year to year, or until the said ground shall be wanted to enlarge the capacity of said canal, for the best price that can be obtained to be paid into the canal fund.

SEC. 17. (MEASURES FOR CONSTRUCTING.) They shall take efficient and proper measures for the immediate construction of the said canal; shall put such parts of it as they may deem proper under contract as hérein provided and shall have the

general care and superintendence thereof.

SEC. 18. (INSPECT ACCOUNTS.) They shall inspect and examine into the accounts, books, state of the treasury and all of the proceedings of the treasurer and of the acting commissioner.

SEC. 19. (FURNISH MEANS.) They shall furnish the acting commissioner with all proper means and facilities that may be necessary to enable him to discharge the duties herein imposed upon him.

Sec. 20. (Powers.) They shall have full power and authority in their good judgment to do, in relation to the construction and completion of the said canal, all things, not otherwise herein provided for.

Sec. 21. (May Use Lands, Water, Streams.) It shall be

Sec. 21. (May Use Lands, Water, Streams.) It shall be lawful for them to enter upon and use any lands, water, streams and materials of any description necessary for the

prosecution of the works contemplated by this Act.

Sec. 22. (To Employ Agents, Engineers.) They may employ such and so many, agents, engineers, surveyors, draftsmen and other persons as they may judge necessary to enable them to discharge their duties as commissioners, and may pay such compensation as they shall judge reasonable to each person so employed.

Sec. 23. (Notice of the Entering into Contracts.) Public notice shall be given of the time and place at which proposals will be received for entering into contracts; which notice shall be previously published for at least six weeks, in a newspaper printed at Chicago and in such other papers either in this

State or elsewhere as may be deemed proper.

SEC. 24. (Proposals.) Proposals for contracts shall be sealed and shall be for a sum definite and certain, as to the price to be paid or received, and shall be let to the lowest and most responsible bidder, accompanied with good and sufficient security for the faithful performance of such contract.

Sec. 25. (To Let Out Contracts.) And it shall be the duty of the commissioners to let out all contracts for labor on conditions to be expressed in the contracts, as will authorize said commissioners to declare all contracts to be abandoned and to relet the same to more efficient contractors, whenever in the opinion of the acting commissioner, or the principal engineer on the work, the contractor or contractors refuse or neglect to prosecute his or their contract, with a force proportionate to the amount of work to be performed and the time within which the same by the terms of the contract is required to be completed; and in all cases where an unfinished contract shall be declared to have been abandoned as aforesaid, the percentage on the amount of work performed, which the commissioners are required to retain until the completion of the job, shall be forfeited to the use of the canal fund.

SEC. 26. (CONTRACTS TO BE RETURNED TO AUDITOR.) All contracts concerning the contemplated canal shall be made in writing under the seal of the board, and of each contract, three copies shall be executed by the parties, one of which shall be

retained by the board, and one shall be immediately forwarded to the Auditor of Public Accounts and by him filed in his office.

SEC. 27. (MATERIALS EXEMPT FROM EXECUTION.) All materials procured or partially procured under any contract with the commissioners, shall be exempt from execution; but it shall be the duty of the commissioners to pay the money due for such materials to the judgment creditor of the contractor under whose execution such materials might have been sold upon his producing to them due proof that his execution would have so attached, and such payment shall be held a valid payment on the contract.

SEC. 28. (DEATH OF CONTRACTORS—PROVISO.) In case of the death of any canal contractor who shall at the time of his decease, be indebted to any laborers for work done on the canal, it shall be lawful for the board, if they think proper to pay such laborers out of any money that may be due to the deceased contractor, and the receipt of such laborers shall be a good voucher in offset to the sum due the deceased contractor, from the board, on the final settlement between them and his executors or administrators; provided, that the said persons shall first obtain a judgment against the administrator of such deceased contractor, and produce a certificate from the court, judge or justice of the peace, that the judgment was rendered for work done on the canal or for materials furnished therefor and for no other cause.

SEC. 29. (RULES AND REGULATIONS.) The board shall from time to time make such rules and regulations, not inconsistent with the laws of this State, in respect to the persons employed about the canal, injury done to the said canal or locks, and the management and navigation of the same, and impose such forfeitures of money for the breach of such rules and regulations, as they may judge reasonable, but no forfeiture imposed, shall for a single offense exceed the sum of fifty dollars over

and above the amount of actual damage done.

SEC. 30. (To BE POSTED.) They shall cause a sufficient number of such rules and regulations to be posted up for public inspection, and shall transmit a copy of them, from time to time to the Governor, as they may be made, in their next quarterly

and annual reports.

SEC. 31. (FILED IN AUDITOR'S OFFICE.) All rules, regulations, and forfeitures, established by them as aforesaid, shall be filed in the office of the Auditor, and a copy thereof certified by him under his hand and seal of office, shall be received

in all courts of law as due proof, that such rules, regulations

and forfeitures were by them established.

Sec. 32. (To Select Canal Route—Townsite and Lay Off Lors.) The commissioners shall examined the whole canal route, and select such places thereon as may be eligible for townsites, and cause the same to be laid off into town lots, and they shall cause the canal lands in or near Chicago, suit-

able therefor, to be laid off into town lots.

SEC. 33. (To SELL LOTS IN CHICAGO AND OTTAWA-PROVISO.) And said board of canal commissioners shall on the twentieth day of June next, proceed to sell the lots in the town of Chicago and such part of the lots in the town of Ottawa, as also fractional section fifteen, adjoining the town of Chicago, it being fire laid off and subdivided into town lots, streets and alleys, as in their best judgment will best promote the interest of the said canal fund; provided, always, that before any of the aforesaid town lots shall be offered for sale, public notice of such sale shall have been given in such newspapers, not less than five in number, including the one printed at Vandalia, either in this or other states as the board may thing best, at least eight weeks prior to any sale; provided, further, that if no sale be made on the day herein named, such sale may be made at any time thereafter, upon giving the notice and upon the terms herein required.

SEC. 34. (TO MAKE OUT A LIST OF LOTS, &C .- CERTIFY THE SAME TO THE TREASURER-SECOND SALE-PROVISO-IMPROVE-MENTS MAY BE REMOVED BEFORE SALE.) It shall be the duty of the canal commissioners, before the day appointed for any sale of lots, to make a list of the lots intended to be offered, describing them by their numbers, and value, each lot separately and certify the same under their hands and seals, which list and certificate shall be filed with the treasurer and preserved, and no lot shall be sold for less than the valuation; and all lots remaining unsold shall be again advertised for sale in the manner aforesaid, and said commissioners shall continue from time to time to advertise for sale all lots remaining unsold, at any public sale, until the whole shall be sold, and no lot shall be sold, except at a public sale, to the highest bidder; provided, that all persons who may have made improvements upon any of the lots authorized to be sold shall be permitted to remove such improvement at any time before the day fixed for the sale of any such improved lots, being responsible for all unnecessary damages done or suffered by such removal.

SEC. 35. (TERMS OF SALE-WASTE.) The terms of sale shall

be as follows, to wit: one-fourth of the purchase money to be paid in advance at the time of purchase, and notes taken for the payment of the residue in three equal annual installments, bearing an interest of six per cent. per annum, payable annually in advance, and a failure to pay such interest or residue of such principal within twenty days after the same or any installment thereof becomes due, shall forfeit to the State for the benefit of the canal fund, the said lot or lots, and all claim thereon; and if any purchaser before forfeiture, shall commit unnecessary waste upon any lot or lots not paid for, he, she or they, so offending shall be subject to an action at law for damages to said commissioners, and a certificate of the acting commissioner of any forfeiture, shall authorize the sheriff of the proper county, with the posse comitatus, to give such board possession of such forfeited lot or lots, on behalf of the State, and the lot or lots so forfeited as aforesaid shall be resold without let or stay, extent of time or subsequent relief of any kind whatever, the same bringing the appraised value.

SEC. 36. (SECRETARY AND TREASURER TO ACT AS REGISTER AND RECEIVER.) In all sales of canal lots, the secretary and treasurer shall act as register, and receiver, and shall be governed by the same rules, that now govern registers and receivers in the United States land offices in this State, except as is here-

in provided.

SEC. 37. (TREASURER TO GRANT CERTIFICATE.) It shall be the duty of the treasurer upon the payment of the purchase money, to grant to the purchaser or purchasers, a certificate, containing a description of the land or lots purchased, and the price for which the same was sold and shall forward a duplicate of such certificate to the Auditor of the State, who shall record the same; and the person holding such certificate shall upon presenting the same to the Governor receive a patent for the land described therein, signed by the Governor, and countersigned by the Secretary of State, with the seal of the State affixed thereto.

SEC. 38. (MONEYS TO BE DEPOSITED IN BANK.) All monies paid to the treasurer for the purchase of any canal lands or lots shall be by him immediately deposited in some bank, under the direction of the Governor, for the payment of the interest

of the canal loan, and for work done on the canal.

SEC. 39. (NO COMMISSIONER TO PURCHASE LANDS OR LOTS—COMMISSIONER TO BID FOR LAND OR LOT FOR THE STATE—PROVISO.) None of the Board of Canal Commissioners shall be allowed to purchase any of the canal lands or lots herein author-

ized to be sold, nor shall they, or either of them directly or indirectly, be concerned in any such purchase or have any manner of interest therein, and all sales in which the said commissioner, or any of them, shall be in any way interested, shall be absolutely null and void, the purchase money shall be forfeited, and the land shall revert to the canal fund; but said canal commissioners, or either of them, are hereby required and authorized to bid for any tract or lot of land so offered for sale, if in their opinion the interest of the canal fund requires it, and in such case the bid shall be in the name of such commissioner for the use of the State, and the said lot or tract shall revert by such bid to the State for the use of the canal fund, and shall be subject to sale thereafter, as other lots or tracts are now, or hereafter may be by law subject to sale. Any commissioner who shall be guilty of a violation of the provisions of this section shall be deemed to have perpetrated a fraud, and upon indictment and conviction thereof in any court having competent jurisdiction, shall be punished by forfeiture of his office, and fined in a sum not less than one thousand nor more than five thousand dollars; provided, that a prosecution for such offense shall be commenced within ten years after the commission of the same.

SEC. 40. (PERSONS COMBINING AT SALE NOT TO BID AGAINST EACH OTHER-Proviso.) If any two or more persons shall combine themselves together for the purpose of lessening competition at the sale of any of the canal lands or lots, or if they shall agree or have any understanding among themselves, that they will not bid upon one another at any such sale for the purpose of obtaining the said canal lands or lots at a low price; the same shall be deemed a fraud and any person or persons convicted thereof, in any court having competent jurisdiction shall be fined in a sum not less than one hundred nor more than one thousand dollars, one moiety thereof, to the use of the person informing, and the other moiety to the canal fund, and any patent issued for any lands or lots purchased as aforesaid shall be absolutely null and void; the money paid therefor shall be forfeited, and the lands or lots so purchased shall revert to the canal fund. And it is hereby declared to be the duty of the State's Attorney to prosecute for all such offenses; provided, that all such prosecutions, shall be commenced within ten years after the commission of the offense.

SEC. 41. (REVENUE, TOLLS, &c., PLEDGED.) The revenues arising from the Illinois and Michigan canal, and from the lands granted, or that may hereafter be granted to the State of Illinois, by the Congress of the United States, for the con-

struction of the said canal, and the net tolls thereof, are hereby pledged for the payment of the interest accruing on the stock, that may be created in pursuance of this Act, and for

the reimbursement of the principal of the same.

SEC. 42. (MAKE REPORT TO THE GOVERNOR, QUARTERLY) The board of commissioners, shall, quarterly, viz.: on the first Monday of March, June, September and December in each year. make a minute and particular report to the Governor, which report shall set forth in a plain and intelligible manner, all of their acts and doings in relation to the said canal, and the canal lands and lots, all of the money received and expended, the work done, and the price allowed for the various kinds of work, the contracts made, with whom made, and the security given, the number of engineers, draftsmen, clerks and agents of every description by them employed, and the amount of compensation paid to each, the progress of the canal, their contemplated plans for the next three months, with an estimate of the probable amount of money, that will be required to be expended for canal purposes, during that time together with such other matters and things as they may see fit to add; and also the amount, time and rate of any loan made by virtue of this Act, which report or the outlines thereof, the Governor shall cause to be published.

SEC. 43. (ANNUAL REPORT.) They shall annually on the first Monday of December, make a report to the Governor, setting forth all of their acts and doings in relation to the canal and canal lands and lots, during the previous year, in like manner as is required of them in their quarterly reports, containing such statements, and estimates for the year as their

quarterly reports do for the quarter.

SEC. 44. (COMMENCEMENT AND TERMINATION.) The said canal shall commence at or near the town of Chicago, on canal lands and shall terminate near the mouth of the little Vermillion in La Salle County and on land owned by the State.

SEC. 45. (ACT REPEALED.) The Act entitled an Act for the construction of the Illinois and Michigan canal, approved February the tenth, eighteen hundred and thirty-five, is hereby repealed, and any canal commissioner heretofore appointed under any law of this State be and the same is hereby declared to be out of office from and after the passage of this Act, any law to the contrary notwithstanding.

JOINT RESOLUTION OF THE SENATE AND HOUSE OF REPRESENTATIVES OF THE STATE OF ILLINOIS IN 1861.

(Laws of Illinois, 1861-3, p. 277.)

JOINT RESOLUTION IN RELATION TO THE IMPROVEMENT OF NAVI-GATION OF THE ILLINOIS RIVER.

Resolved by the Senate, the House of Representatives concurring herein. That the Board of Trustees of the Illinois and Michigan Canal be and are hereby authorized and instructed to cause prompt and thorough surveys, examination and estimates to be made of the Illinois River, and of the Illinois and Michigan Canal, and also of portions of the DesPlaines and Chicago rivers, and of the portage between said rivers, for the purpose of accurately ascertaining the comparative value, cost, efficiency, benefits and advantages, direct, prospective and incidental, of the different methods proposed or desirable for improving the navigation of the Illinois River, by dredging or excavation of the channel and wing dams, or by supplying water from Lake Michigan, through the enlargement and deepening of the Illinois and Michigan Canal, or otherwise, or by opening a channel from Lake Michigan by way of the south branch of the Chicago River and Mud lake to the Desplaines river, and down said canal to a point that will secure a free flowing, ample and never-failing supply of water, sufficient for the navigation of the Illinois river at all seasons and times, when not obstructed by ice. Such surveys, examinations and estimates to include a plan of enlargement of the Illinois and Michigan Canal, sufficient for the introduction and use of stern-wheel river steamers and propellers upon it, and also of side-wheel river steamers, and to include also an estimate for the channel hereinbefore mentioned, of sufficient size to admit of full and free steamboat navigation from the Illinois River to Chicago and Lake Michigan, as well as a size sufficient for supplying water for all the deficiencies of navigation in the Illinois river, at all seasons. And the said trustees are hereby authorized to employ efficient and competent engineers of high character, to make such surveys, examinations and estimates and to avail themselves, in their labor of all reliable surveys and data heretofore made or obtained of the said Illinois river and Illinois and Michigan Canal, and to report the result of all such examinations and surveys to the Governor of the State, as soon as the same shall be completed, and to furnish ample abstracts thereof to the

newspapers of the State for publication, so far as may be desired by them. And the said Board of Trustees are hereby authorized to pay the necessary expenses of said surveys, estimates and examinations out of any funds that may be received by them from the earnings of the Illinois and Michigan Canal; provided, that the expenses thereof shall not exceed the sum of six thousand dollars. Provided, that no payment shall be made by the said trustees, for or on account of any liability heretofore incurred, or moneys heretofore advanced for surveys, plats or otherwise, exceeding twelve hundred dollars.

JOINT RESOLUTION OF THE SENATE AND HOUSE OF REPRESENTATIVES OF THE STATE OF ILLINOIS, IN 1889.

(Laws of Illinois, 1889, pp. 375-376.)

RIVER IMPROVEMENT, DES PLAINES AND ILLINOIS.

Whereas, The Illinois river, from La Salle to Grafton, is the remnant of an ancient stream bed bordered by wide and low bottom land, much cut up by lake, bayou and marsh; an alluvial stream of small, low water volume and sluggish current, with a declivity of only 26 feet in 225 miles, a declivity so small as to require a large volume of water to maintain an effective channel; a stream which in its natural condition is able to maintain but a small depth through the deposits with which the tributaries constantly tend to choke the channel; a tendency ever increasing with the inhabitation of the water-shed and the cultivation and reclamation of lands.

Whereas, The erection of dams with a view to the creation of pools of slack water for the purpose of navigation, diminishes the scouring force of the current at medium and low stages and promotes channel decay, causes deposits in the mouths of tributaries and the more ready overflow of the bottom lands; and generally the tendency is to restore the natural channel of equilibrium at a higher level with great ultimate injury to the valley from overflow and unhealthfulness, a tendency already exhibited in a notable degree from the conditions created by the dams erected by the State at Henry and Copperas creek in 1872 and 1877 respectively.

Whereas, The completion by the United States of the dams at LaGrange and Kampsville will raise the general level of the river below Copperas creek by several feet and promote all those injurious tendencies to channel decay, with overflow

and unhealthfulness already exhibited through the agency of

the state works at Henry and Copperas creek.

Whereas, The official report of the United States for 1868 showed that it was practicable to obtain by dredging and a minimum low water volume at Peru of 38,000 cubic feet per minute, a channel for navigation of a width of 160 feet and a depth exceeding four feet, and the official report for 1880 showed that it was practicable to obtain a channel for navigation 200 feet wide and six feet deep by dredging, and a minimum flow of 94,000 cubic feet per minute in the river below Copperas creek, and that the cost was not materially different from the cost of the improvement by locks and dams.

Whereas, The present addition to the low water volume of the Illinois river through the summit level of the Illinois and Michigan canal from Lake Michigan more than doubles the volume of water used in the estimate of 1868 for the channel below Peru and adds 50 per cent. to the volume used in the estimate of 1880 for the channel below Copperas creek, and said contribution from Lake Michigan will be increased in the immediate future, thus enabling the depth now projected for navigation below Peru to be obtained by channel improvement at moderate cost and with decided advantage to material interests and to healthfulness along the valley.

Whereas, It is contemplated to increase the volume from Lake Michigan to 300,000 cubic feet per minute within a few years and ultimately to add 600,000 cubic feet or more, thus enabling a large depth for navigation to be obtained by an improved channel, and that said channel will be self-sustaining and self-improving and will discharge flood waters more readily, thus benefitting the bordering lands and in-

creasing the healthfulness of the valley.

Whereas, Works now projected by the City of Chicago will form part of a water-way of large proportions from Lake Michigan via the DesPlaines and Illinois rivers to the Mississippi river, of which the dams and locks upon the alluvial section of the Illinois river can form no part and which, if allowed to remain, will increase the overflow and be detrimental to the welfare of the Illinois valley and the interests of the State. Therefore be it

Resolved, by the Senate, the House of Representatives con,

curring herein,

1. That it is the policy of the State of Illinois to procure the construction of a water-way of the greatest practicable

depth and usefulness for navigation from Lake Michigan via the DesPlaines and Illinois rivers to the Mississippi river, and to encourage the construction of feeders thereto of like

proportions and usefulness.

2. That the United States is hereby requested to stop work upon the locks and dams at LaGrange at Kampsville and to apply all funds available and future appropriations to the improvement of the channel from La Salle to the mouth with a view to such a depth as will be of present utility and in such manner as to develop progressively all the depth practicable by the aid of a large water supply from

Lake Michigan at Chicago.

3. That the United States is requested to aid in the construction of a channel not less than 160 feet wide and 22 feet deep with such a grade as to give a velocity of 3 miles per hour from Lake Michigan at Chicago to Lake Joliet, a pool of the DesPlaines river, immediately below Joliet, and to project a channel of similar capacity and not less than 14 feet deep from Lake Joliet to La Salle, all to be designed in such manner as to permit future development to a greater capacity.

Adopted by the House May 27, 1889. Concurred in by the Senate May 28, 1889.

EXTRACTS INTRODUCED IN EVIDENCE ON THE PART OF THE SAN-ITABY DISTRICT IN RELATION TO THE DEPTH OF WATER UNDER-NEATH THE KEEL OF VESSELS IN CANALS.

EXTRACTS FROM PAPERS DELIVERED BEFORE THE INSTITUTION OF CIVIL ENGINEERS (GREAT BRITIAN).

EXTRACT FROM A PAPER BY SIR CHAS. HARTLEY, K. C. M. G. M. INST. C. E., ENTITLED "A SHORT HISTORY OF THE ENGINEERING WORKS OF THE SUEZ CANAL," DELIVERED ON MARCH 13, 1900.

Information collected by the sub-commission (1884-5) during the inspection of the Isthmus opinions of experts as to the adequacy of the proposed enlarged canal

2. How much water should a large vessel have under her keel to enable her to steer well at a speed of 8 knots an hour?

Replies-The answers vary from a minimum of 6 inches

to a maximum of 6 feet under the keel, but the average depth demanded by the captains was 3½ feet and by the pilots 3 feet."

Institute of Civil Engineers, 1899-1900, Part 3, Vol.

CXLI, page 168.

"Actual and Prospective Depths in the Canal.—On the 1st January, 1899, there was an available depth of 9 metres (29 feet 6 inches) over an aggregate length of 90 kilometres, and by continuing to dredge down to 9.40 metres (31 feet) as at present practiced, the engineers of the company hope by 1902 to obtain the latter depth throughout the whole length of the canal. It should here be explained that this contemplated depth of 9.50 metres in 1902 includes the provision of a receptacle for deposit ½ of a metre deep over the entire bottom width of the canal from end to end.

Depth at Suez.—At the Suez entrance, at the present time, a vessel drawing 7.80 metres (the maximum draught allowed) has a depth of 1 metre under her keel at ordinary low water of spring tides, and a minimum of 40 centimetres under her keel at an extraordinary low

tide."

Institution of Civil Engineers (1899-1900) part 3, Vol. CXLI, page 179.

Extracts from Appendix 4, Attached to Paper of Sir Chas. Hartley, Above Referred to Entitled "Regulations for the Navigation of the Suez Maritime Canal. Issued January, 1899.

"The transit through the Suez Canal is opened to ships of all nationalities, provided that their draught of water does not exceed 7 metres 80 centimeters (25 feet 7 inches English), and that they conform to the following conditions:

Sailing vessels above 50 tons gross are bound to be-

towed through.

Steam vessels may pass through the canal by means of their own steam power or be towed subject to the conditions hereinafter notified.

Of course the towage of steamers through the canal is not compulsory on the company; it will only be performed in so far as they have unengaged tug boats."

Institution of Civil Engineers (1899-1900) part 3, Vol. 3,

CXLI, page 187.

EXTRACT FROM DISCUSSION OF SIR CHAS. HARTLEY'S PAPER BY DR. E. L. CORTHELL.

"Dr. E. L. Corthell contributed the following correspondence on the subject- he desired to refer to only one point in the paper, viz., the depth of the channel. It was an interesting coincidence that, at the time the paper was under discussion, he had been engaged in writing a paper for the International Congress on Navigation about to be held at Paris, in which he predicted that a depth of 31 feet (9.50 metres) would be necessary by the end of the next quarter of a century. During the past three years he had investigated this matter very carefully, and had given, in a paper read before the American Association for the Advancement of Science, many facts of this special subject of dimensions of vessels, and also the reasons for the rapidly increasing draughts. He worked out from the records of the earlier steam ships, and through successive periods up to 1898, the loaded draught of the 20 largest steam ships, and predicted that in 1923 the draught would be 31 feet, and in 1948, 33 feet. Since that time he had obtained more recent information, all confirmatory of the opinion expressed in 1895 by the author, that a depth of 31 feet would be necessary in the Suez Canal. All of the very deep draught vessels were not trans-Atlantic liners. The draught of the ordinary cargo steam ship was rapidly increasing. As to Atlantic liners, there were at the beginning of 1899 at least thirty-four with a loaded draught of 28 feet and over, nineteen of 29 feet and over, nine of 30 feet and over, and four of 31 feet and over. Of the regular steam ship lines trading at the Port of New Orleans, which might be taken as a characteristic first class American Port, and where the present available depth (not through the South Pass jetties, where the depth was 30 feet, but within 12 miles of the South Pass itself) was nominally 26 feet, but really not over 25 feet, the loaded draught was as follows: forty-two vessels with a draught of more than 26 feet, thirty over 27 feet, fifteen over 28 feet, ten over 29 feet, two over 30 feet, and two with a draught of 30 feet 9 inches. The view expressed by a large number of the experts upon the question submitted to them by the Sub-Commission in 1884, namely, that there should be 3 feet or 31 feet of water under the keel of a vessel moving at any speed,

was borne out by the experience of pilots and navigators elsewhere. With less depth than this under the keel it was difficult to steer a vessel in a restricted channel, a fact which had been frequently noticed in the channel through the South Pass, where there was often a restricted depth under the keel. It might be mentioned that the proposition now before the United States Congress for the deepening of the mouth of the Southwest Pass of the Mississippi river, which was about five times the size of the South Pass, provided for a depth of 35 feet, throughout the channel. The depth of the channel provided for the entrance to the New York Harbor, the contract for which had been made by the government, was forty feet; and it was proposed at Philadelphia, Baltimore and Boston to make channels 30 feet deep-in all cases below low water. There were the strongest possible reasons from every point of view-navigation, construction and economy-for deepening the channels into all first class ports to allow of the free movement of steam ships drawing, when full loaded, 31 feet."

Institution of Civil Engineers 1899-1900, part 3, Vol. CXLI,

pages 206-207.

EXTRACT BEING THE REPLY OF SIR CHAS, HARTLEY TO REMARKS OF DR. CORTHELL

"The remarks of Dr. Corthell on the advisability of providing an ample depth of water in maritime canals and harbors for vessels of the largest class, were a valuable contribution to the Discussion, coming as they did from an expert of high authority in the United States on all matters connected with the safe navigation of vessels in contracted channels. He was gratified to notice that the conclusions arrived at in this respect by Dr. Corthell were fully shared, not only by Sir John Wolfe Barry and Mr. Vernon Harcourt, but also by two other distinguished authorities of European reputation who had contributed to the Discussion orally and in writing, namely, Sir Edwyn Dawes of London, and Mr. Fulscher of In short, there seemed to be a consensus of opinion in favor of providing an ultimate depth of ten metres (32 feet 9 inches) in the Suez Canal from sea to sea, as he had ventured to recommend."

Institution of Civil Engineers, 1899-1900, part 3, Vol.

CXLI, page 212.

EXTRACT FROM THE PAPER PREPARED BY LEVESON FRANCIS VERNON-HARCOURT, M. A. M. INST. C. E., DELIVERED BEFORE THE DUSSELDORF NAVIGATION CONGRESS, 1902.

Remarks on the Kaiser-Wilhelm Canal.-Although the commercial traffic along the canal may not be as large as was anticipated, it has steadily increased; and as the canal was constructed for naval purposes, and not primarily for commerce, the traffic it has attracted is so much to the good towards the repayment of the cost of the works undertaken The value of the as a measure of national importance. waterway, in view of the large fleet usually stationed in Kiel Harbor, and the growing importance of Kiel as a naval arsenal, is sufficiently evident; but the canal, with a bottom width of only 72 feet and six passing places in sixty-one miles, would require to be widened if it should ever be called upon to provide for a large traffic. Thus its width compares unfavourably with the bottom width of the Soulanges Canal of 96 feet, with a depth of 171 feet, only intended to accommodate vessels of about 2,000 tons and 14 feet draught. Provision, however, has been made to some extent on the Kaiser-Wilhelm Canal for a future widening, by means of the berm formed at the side in constructing the canal.

Institution of Civil Engineers (1902-03), Part II, Vol.

CLII, page 227.

EXTRACTS FROM PAMPHLET ENTITLED LAKES AND GULF WATERWAY AS RELATED TO THE CHICAGO SANITARY PROBLEM BY LYMAN E. COOLEY, 1890.

8. A Channel of Adequate Depth.—An absolute depth of ten feet below low water, however, admits no clearance beneath the boats. Actually, a greater depth must exist for the boat to navigate at all, and the greater the clearance the better. Maj. A. Mackenzie says:

"A boat drawing four feet to run and handle well should have at least six feet and her speed will be con-

siderably increased on a depth of eight feet.

The large side-wheel boats run during the greater part of the season, but during low water do not go up higher than LaCrosse. They could always reach Hastings as well as LaCrosse, but between these points the crossings are so numerous, and deep pools so short, that the river is, as they term it, 'slow.' '' (See Report Miss. Riv. Com., 1881, p. 16.)

"It is a well known fact that vessels of every class are propelled at much greater speed and economy in deep than is possible in shallow water." (Report Chief

of Engineers, 1868, p. 447.)

Capt. Marshall admits (p. 11) that "Every increase in depth and width of channel up to a certain limit will increase the facilities for navigation." Maj. Mackenzie shows that boats actually do not run on the Upper Mississippi where the depth is sufficient because the smaller proportion of deep water makes navigation too slow and tedious. An occasional bar over which for a short distance the depth is just sufficient for a boat to float, is very different from a channel of a uniform and no greater depth through which a boat must be propelled for thirty miles and probably a good fraction of

seventy more.

No channel should be contemplated across the Chicago Divide that does not give from two to three feet depth in excess of the draft of boats as a virtual necessity, and an excess of four or five feet would be justifiable, and up to this limit probably far more valuable than increase in width. Taking ten feet below low water of Lake Michigan as the absolute minimum for draft, then the channel should have not less than twelve feet below that line and fourteen feet is fully justifiable for easy navigation. The channel of eight feet is none too much for such boats as now run upon the Upper Mississippi and the tributaries, as the Tennessee, Cumberland, Upper Ohio, Missouri, Arkansas and Red, but is entirely inadequate for those of the lower Mississippi.

Lakes & Gulf Waterway, 1890, page 19.

EXTRACT FROM A PAPER BY A. E. KEMPEES, C. E., ROYAL ENGINEER IN HOLLAND. THE ENLARGEMENT AND IMPROVEMENT OF THE NORTH SEA CANAL OF HOLLAND (AMSTERDAM SHIP CANAL). PREPARED FOR THE INTERNATIONAL ENGINEERING CONGRESS OF THE COLUMBIAN EXPOSITION 1893.

"The present Special Regulations of Police for the North Sea Canal (established by Royal Decree of May 23d, 1892, Official Gazette, 113) allows to vessels entering the canal a maximum of draught, wherever measured, of—

7.30 m. at a level of 0.30 m. below A. P. and higher,
7.20 " " 0.40 " " "
7.10 " " 0.50 " " "
With a view to the draught of inward-bound vessels

being increased through their passing from sea water into fresh or brackish water, the regulations direct that for the draught such vessels will get in the canal a standard of 0.1 m. shall be added to their draught in the outer harbor or outer canal. The maximum of breadth allowed to vessels is now 17.75 m. for the main canal; the maximum of length, 115 m., for lockage through the North Sea locks, and 90 m. for lockage through the Orange locks at Schellingwoude. The present dimensions of the canal and harbor are by no means calculated to open the way to the docks of Amsterdam to the largest-sized ships, although they could pass the new locks at Ymuiden. The stages for loading and unloading vessels will also require important improvements before they are fit for the giants of modern navigation."

American Society of Civil Engineers Transactions, Vol. 30,

1893, page 404.

EXTRACT FROM A PAPER BY J. FULSCHER, GEHEIMER BAURATH,
MEMBER OF IMPERIAL BOARD OF CANAL COMMISSIONERS AT KIEL,
GERMANY. TRANSLATED FROM THE GERMAN BY KENNETH ALLEN, M. AM. Soc. C. E.

PREFARED FOR THE INTERNATIONAL ENGINEERING CONGRESS OF THE COLUMBIAN EXPOSITION, 1896.

"The Cross-Section (see the accompanying map.)—The bed of the canal in the straight reaches and the curves of over 2500 m. (8 200 ft.) radius has a width at the bottom of 22 m. (72.16 ft.), and up to 3 m. (9.84 ft.) above the bed a 3 to 1, and, to 4 m. (13.12 ft) height, a 2 to 1 slope. The upper portions of the profile are built differently for the reaches in the lowlands from those in the higher lands. In the latter reaches, a berm at a height of 7 m. (22.96 ft.) above the bed, that is, about 2 m. (6.56 ft.) below the mean water-level, connects with a 1½ to 1 slope protected by stone, which reaches to 1 m. (3.28 ft.) above the usual water-level. At this height lies a second berm 2.5 m. (8.2 ft.) wide which joins the excavated slope of 1½ to 1.

In the lowlands the lower berm is widened on both sides, in order that the cross-section may be widened

later without disturbing the dikes.

The dikes, which are to be built on either side, are given slopes of 2 to 1 where the underlying ground has

sufficient firmness—natural or artificially increased by laying sand; but where long stretches have a soft foundation, in order to distribute the pressure as much as possible, they are given an inner slope of 6 to 1.

The cross-section of the canal has, at the lowest stage of water, 6.17 m. (20.24 ft.) depth below the surface, an available width of 36 m. (118.08 ft.), and offers a passage to the largest steamers employed in the East Sea traffic, which, with a few exceptions, have a draft of not over 6 m. (19.68 ft.), with a berm of 12 m. (39.36 ft.)."

American Society of Civil Engineers Transactions, Vol. 30,

1893, page 425.

EXTRACT FROM REPORT OF THE UNITED STATES DEEP WATERWAY COMMISSION OF 1896 IN REFERENCE TO THE WORK OF THE AMERICAN SECTION. THE FOLLOWING EXTRACT IS PREPARED BY MR. LYMAN E. COOLEY.

Page 22, Paragraph 22. This Section Relates to a Future Type Vessel drawing 27 to 28 feet of water.

Page 23, paragraph 24. Locks are taken at a depth of 28

feet on the meter sill for the above type of vessels.

Page 23, paragraph 25. Discusses the depth in canal prism and in other restricted channels and lays down the proposition that such prisms and channels should have a depth of 33; feet where feasible, or, 25 per cent. in excess of vessel draught and 20 per cent. in excess of lock depth.

Page 24, paragraph 26. "Discusses a type vessel with a draught of 201 feet for which the lock depth is to be 21 feet

and the channel-ways are to be 25 feet."

The foregoing report discusses future Lake development and sea-board connections on the basis of channel-ways that exceed the draught of vessels by 23.4 per cent. and that exceed the depth in mitre sills of locks by 19 per cent.

Page 28, paragraphs 34 and 35 show that the radical improvements herein outlined will materially change slopes and levels between Lakes Erie and Huron and in the Saint Mary's river and result in the lowering of Lake Michigan-Huron and the Saint Mary's river below the locks.

United States Deep Water-Ways Commission, Report 1896,

pages 22 to 28.

EXTRACT FROM REPORT OF THE UNITED STATES BOARD OF ENGINEERS ON DEEP WATERWAYS TRANSMITTED TO CONGRESS ON DECEMBER 2, 1900.

"Adaptability to Traffic Conditions.

Our vessel No. 1, which is the type vessel adopted for the 21-foot waterway, has a draft of 19 feet and can enter all the important lake harbors as well as navigate along the seacoast. It is, therefor, much better adapted to domestic traffic than vessel No. 2, the type vessel for the 30-foot waterway, since the latter has a draft of 27 feet and can not enter the lake harbors. The smaller vessel is not so well adapted to deep-sea navigation as the larger one."

The above extract is taken from the report of the board, which consisted of C. W. Raymond, Lieut. Col. Corps of Engineers, United States Army, Alfred Noble and George Y.

Wisner.

United States Board of Engineers on Deep Water-

ways, 1900, page 127.

As an appendix attached to the foregoing report is appendix No. 1, entitled "Locks," in which appears the following

extract, p. 140:

"Although the existing channels do not have quite 21 feet of water, the larger ships are designed to be loaded to 19 feet or more. For the rapid and safe movement of a ship in the 21-foot waterway there should be about 2 feet of water under its keel. The larger ships now in use, therefore, have reached the limit of draft that should be permitted in this waterway."

In a report to the Board made by Alfred Noble, one of the members of the Board, occurs the following extract, p. 234:

"First. Ship 480 by 52 by 19 feet draft in the 21-foot channel. A channel 1,000 feet wide is obviously the equivalent of a channel of unlimited width as regards the movement of a ship. The Lake St. Clair observations show that in the shallow water of that lake, where the depth of water exceeded by about 2½ feet the draft of the boat, the loss of speed was considerably less than 20 per cent.; 20 per cent. was taken for this discussion to be on the safe side."

And in a report signed by George Y. Wisner, one of the members of the Board, entitled "Comparison of Waterways,"

appears the following, p. 237:

"A draft of 19 feet is necessary for vessels best adapted for the commerce and safe navigation of the lakes, and since the free movement of ships in shallow water requires at least 2 feet of water between the keel and bottom where the shallow channel is of considerable length, it appears that 21 feet is about the least depth which can be established for the lake waterways consistent with securing a minimum rate of transportation for ships best adapted for the lake service."

p. 240.

Referring to Tables III and V of Appendix No. 4 it will be seen that the type ships of 19 feet and 27 feet draft, capable of steaming 121 miles per hour in the open lake, are estimated as being able to maintain 7.55 miles and 7.47 miles per hour, respectively, on tangents in waterways 21 and 30 feet deep. p. 246.

Many of the South Atlantic ports will not admit ships of over 20 feet draft, and therefore the expenses for transfer of domestic freight, if carried in deep-draft ships, would probably be fully as large as for transfer of export traffic through the canal if transported in vessels adapted to 21-foot channels through the connecting waterways of the Great Lakes."

REPORT MADE TO THE DEPARTMENT OF PUBLIC WORKS BY THE GEORGIAN BAY SHIP CANAL IN 1908, ON WHICH PROJECT THE REPORT WAS MADE BY THE COMMISSIONERS, EUGENE D. LA-FLEUR, CHIEF ENGINEER; A. St. LAURNET, ENGINEER IN CHARGE; C. R. COURTLEE, DISTRICT ENGINEER, AND S. J. CHAP-LEAU.

The Board in its report dated January 20, 1909, says, p. 19: "Sir:-The government surveys and investigations regarding the feasibility and probable cost of a deep waterway from the Great Lakes to the Seaboard, by way of the French and Ottawa rivers, initiated in 1904, by the Honourable C. S. Hyman, Minister of Public Works, under authority of parliament, and continued under your direction, have led your engineering board to formulate the following results and conclusions:

That a 22-foot waterway for the largest lake boats (600 ft. x 60 x 20 ft. draft) can be established for one hundred million dollars (\$100,000,000) in ten years, and that the annual maintenance will be approximately \$900,000, including the operation of storage reservoirs for the better distribution of the flood waters of the Ottawa river."

A special report was made to the Board by C. R. Courtlee referring to the canal reach from Montreal to Des Joachims,

in which he says, p. 69:

"In designing these reaches, it was necessary to know the style of navigation proposed. A depth of 22 feet was set by the department, which indicates a vessel of 20-foot draft, corresponding to the large lake boat. I will therefore describe this draft; her speed, load, habits, etc., and also the channels, curves and currents which the lake boat is accustomed to navigate.

Long boats, especially when deeply laden, so that they, as it is said, 'smell the bottom' are very liable to 'take a sheer' and run aground or collide with an approaching boat; consequently, a 22-foot channel is provided for a 20-foot draft boat.

p. 71.

Depth on Miter Sills of Locks—Ample allowance beneath a vessel's keel is always desirable. A boat is said 'to squat' or settle down when in motion. If drawing loaded 19 feet at the dock, the draft will be 20 feet when the propeller is moving. If a vertical steel plate, 60 feet long and 20 feet deep, were forced broadside on through the water at 18 feet per second (12½ miles an hour), the commotion caused by a ship would be imitated. There would be a piling up of water in front, an escape at each side, and a flow into the depression behind.

Between a vessel and the channel bottom there is a tendency to compress the water, making the boat tremble as though it were moving on rollers. This tends to sweep loose stone and debris into heaps upon which the flat steel bottoms of heavy carriers may scratch and grind.

A minimum depth of 22 feet has been allowed over the top of the miter sill against which the lock gates close. The lock floor is still lower.

p. 167.

The above elevation creates the storage called for, of 4 feet throughout the summit level, or 4 feet over the 22 feet standard depth on the sills of the summit locks." Report of Courtlee, Georgina Bay Ship Canal Survey, pages XIX, 68, 69, 71, 167.

In a detailed report by Mr. Alex. McDougall, M. Can. Soc.

C. E., he says:

"The possibility of giving an available depth of 25 feet from the St. Lawrence Ship Canal to the Recollect lock has been considered, with a view of affording terminal facilities, back of Montreal Island, for vessels of a maximum draft of 24 feet. This would allow the extension of Montreal harbor in a very desirable location, when need would be felt for more space, leaving the front or main part of the harbour free for deeper draft ocean vessels."

Georgian Bay Ship Canal Survey, page 320.

In a subheading of a memorandum entitled "Barge Canal

vs. Ship Canal" occurs the following extract:

"At present all the connecting channels on the lakes are from 19 to 21 feet in depth at low water stage, and a great many harbours will accommodate vessels of 20 feet draft. A decided movement in the deepening of harbors and channels to a depth of 12 feet, by the United States government commenced in the seventies. In the eighties, the tendency was to secure 16 feet, and the policy of securing 21 feet was carried out in the next decade.

Since then the size of vessels has increased gradually and now the commerce of the Great Lakes is carried in

ships drawing 15 to 20 feet of water."

Georgian Bay Ship Canal Survey, pages 395-396. In a paper prepared by Mr. S. J. Chapleau, member of the Board, entitled "Data Relating to Channels Connecting the

Great Lakes," he says:

"It is a question if the depth of 21 feet cannot meet the demands of the lake traffic for the future; 20 feet draft at the extreme low stage means 22 feet to 23 feet draft at mean summer level and while each additional inch draft means 60 to 80 tons additional cargo—depending upon its nature—in the largest carriers, it would seem that the natural increase in the number of lake carriers with probable increased facilities at the Sault Falls in the way of more locks of the same present capacity, would suffice to pass an increasing traffic at less expense than by the deeping of the connecting channels.

In the present case an increased area through the Huron to Erie stretch would affect the level of the former.

not appreciably at first, nor suddenly at any time, but would be shown by gradually lower averages of the mean monthly elevation of the Huron-Michigan basin and consequently in time, of a lower extreme low navigation stage therein.

It must not be inferred from the foregoing that 19 feet draft is the probable limit during the navigation season; a greater draft than that, possibly even up to 23 feet, may be possible during certain stages of the lake levels as it must be remembered that those stages absolutely control

the depths in the artificial channels between.

As to a future depth in the connecting channels between Lakes Erie, Huron and Superior, greater than that of 21 feet during extreme low stage which will eventually be completed, the following quotations from a report of Charles E. L. B. Davis, Lieut. Colonel, Corps of Engineers, United States army, to Brig. General A. Mackenzie, Chief of Engineers (under date of January 12, 1906), may be given here, in which he refers to the Livingstone channel in particular, and the connecting channels between the lakes in general:- 'The depth of 22 feet is recommended for this channel because the future growth of commerce may warrant the expenditure necessary to secure an extra foot over the present depth (21 feet) while the cost of securing 25 feet in these channels and tributary harbours will probably be prohibitive, at least for many years to come." "

Georgian Bay Ship Canal Survey, pages 497-498.

At the 12th International Congress of Navigation held at Philadelphia on May 23, 1912, a general report was made by C. E. Grunsky, of San Francisco, California, in which paper

he said, among other things:

"The following conclusions appear to be justified and are recommended for adoption by the Congress.

1. It is desirable that a limit be set to the draft of

sea going vessels.

2. Government aid should not be extended to the building or operation of sea going vessels whose draft exceeds 32.2 feet.

3. There should be an international agreement fixing the maximum dimensions of sea going vessels built or operated under government supervision, and there are tentatively suggested the following:

	900	feet
Breadth	105	44
Draft	32.	2 44

4. Any maritime canal which has locks with a usable length of 1000 ft., a width of 110 feet and a depth of water on the sill of 35 feet will fulfill every reasonable

requirement of commerce.

5. In a maritime canal a wet section five times as large as the immersed portion of the largest ships which are to use the canal is desirable, as also, a depth of 1 meter under the keel; but these values are functions of the speed at which the canal is to be navigated, and therefore to some extent also of the volume of commerce, and are to be determined by local conditions.

International Marine Eng., p. 222, Vol. 17, 1912. In a paper delivered by Henry Goldmark, entitled "Locks and Lock Gates for Ship Canals," Mr. Goldmark says:

"The depth of water on the sill of the lock should equal the maximum draw of the boats with an additional clear-

ance of 11 to 2 feet."

Transactions Cornell Univ. 1899-1902, Vol. 7-10, p. 76. In an appendix contained in the Report of Board of Consulting Engineers, Panama Canal, 1906, entitled Appendix D, Principal Canals of the World, under the Manchester Ship

Canal, by W. Henry Hunter, appears the following:

"The largest vessels which regularly navigate the canal at present are (1) twin-screw steamers of the Somerset class, 7,010 tons gross register, 460 feet between perpendiculars, by 58.2 feet beam, and (2) single screw steamers of the Silverlip class, 470 feet between perpendiculars, by 55.2 feet beam. The draft of water of these vessels is 25 feet and the areas of midship section are about 1,310 square feet and 1,240 square feet, respectively."

In the same appendix is an article entitled "Suez Canal,"

by E. Quellennec, appears the following:

4. "Cross-Sections.—The average cross sections are figured, four in number, in the annexed sketch. In these sketches the original sections are shown just as they were executed at the time of the construction of the canal. Since then the depth has been changed from 8 to 9.50 meters (26.24 to 31.1 ft.) at least and the bottom width from 22 to 33 meters (72.17 to 108.26 ft.) at least.

5. Authorized Draft.—At present the authorized draft is 8 meters (26.24 ft.); it will be 8.23 meters (27 ft.) from

January 1, 1906."

Report Panama Canal, 1906, pages 171 and 176.

The following matter, to the end of Volume IV, was printed and offered in evidence by the Sanitary District, defendant herein, but is objected to by complainant on the ground that it is incompetent, irrelevant and immaterial. It is not objected that the documents copied are not what they purport to be.

EXTRACTS OFFERED IN EVIDENCE ON THE PART OF THE SANITARY DISTRICT FROM OFFICIAL DOCUMENTS OF THE WAS DEPARTMENT OF THE UNITED STATES AND EXTRACTS FROM THE OFFICIAL PROCEEDINGS OF THE SANITARY DISTRICT OF CHICAGO.

Report of Isham Randolph, Chief Engineer to the Board of Trustees, August 2, 1893.

Page 1360:

"Change in Grade of Main Channel.

The Clerk presented a report, accompanied by three enclosures and drawing from the Chief Engineer with reference to the change in grade of the Main Channel, which matter was referred back to the Chief Engineer at the meeting held June 21, 1893 (page 1293 of the Proceedings); and the report was read.

Mr. Eckhart, seconded by Mr. Kelly, moved that the report be printed, and with enclosures and drawing, be referred to the Joint Committees on Engineering and

Finance.

The motion prevailed unanimously and the report was ordered printed with enclosures and plat so referred.

The following is

The Report:

'Chicago, August 2, 1893.

To the Honorable the Board of Trustees of the Sanitary District of Chicago:

Gentlemen:

As the time is fast approaching when the grade of the channel now being constructed must be finally determined, it seems desirable that you should consider the subject in its bearings upon capacity and cost. For my own enlightenment upon the merits of these questions I have had Mr. Johnston make the calculations necessary for developing the comparative merits of the question involved, and I submit herewith his reports to me. Guided by this information, I am decidedly opposed to a reduction of grade to .053, as recommended by my predecessor, without a compensating enlargement of channel, but I recog-

nize the advantage of raising the grade of mean low water at Station 1480, as urged by him. This result, however, can be accomplished, as shown by Mr. Johnston's report, by deepening the channel to 22 feet. This increased depth between Robey street and Station 1480 would increase the cost of the work about \$200,000, or less than 1½ per cent. This excess of cost, however, will be diminished by an amount not yet ascertained in the cheapening of the work beyond Station 1480, by reason of the lessened depth of cutting required in making the channel.

Respectfully submitted,
(Signed) ISHAM RANDOLPH,
Chief Engineer.

(Three (3) enclosures and drawing.)

Proceedings of the Sanitary District of Chicago, pp. 2688, 2689.

"Report on Depth, Dimensions, Grade, etc., of Main Channel.

The Clerk presented a report from the Chief Engineer, making statement with reference to the depth, dimensions, grade, etc., of the Main Channel as set forth in the report.

The same was read, and, by unanimous consent, was or-

dered printed and placed on file.

The following is

The Report:

To the Honorable the Board of Trustees of the Sanitary

Sanitary District of Chicago:

Gentlemen:

The frequency of inquiries relating to the depth of our Channel prompts me to make the following concise

statement:

The reasons for the depth adopted for the Channel of the Sanitary District are as follows: The ultimate volume of flow determined upon for this Channel is 600,000 cubic feet per minute. The slope or grade of the Channel as finally adopted September 6, 1893 (page 1439 of Proceedings), by your Honorable Board, after careful consideration of the report and recommendations of the Chief Engineer, presented August 2d, 1893 (page 1360 of the Proceedings), is one (1) foot in 40,000 feet or 14

inches per mile nearly, for the earth, and one (1) foot in 30,000 feet, or 3½ inches per mile nearly, for the rock channel. The change of grade then adopted resulted in raising the water surface at the Lockport end two feet, and in deepening the channel as it approached Chicago to an extent which permits the width of the earth sections between the Summit range line and Robey street to be reduced to 183.26 feet for the bottom instead of 202 feet, for the ultimate flow of 600,000 cubic feet per minute thus reducing to a minimum the excavation above water surface.

The width of earth channel in those sections which are under contract, prior to the change of grade here-inbefore referred to, for the maximum flow of 600,000 cubic feet per minute was 210 feet, with side slopes of one (1) foot vertical to two (2) feet horizontal; holding the top width established for the 210-foot channel and maintaining the same side slopes, the bottom width for

the new grade became 202 feet.

With a depth of 22 feet of water, the velocity for 600,000 cubic feet per minute will be at the rate of 1 26/100 miles in earth, and 1 92/100 miles in rock per hour. The wet cross-section in earth for that flow is 5,412 square feet, and in rock 3,542 square feet. The cross-sections used have been demonstrated by careful computations to be about the most economical which could be adopted to give the required flow of 600,000 cubic feet per minute, as set forth in the Sanitary District law,

within the limits of width therein prescribed.

A wider and shallower channel would have involved excavating a very much greater volume of material above the water line, without any compensating capacity in volume of flow. It may be stated that no material excavated above the water surface adds to channel capacity, but every foot in depth below the water surface increases the flowage capacity. The low velocity contemplated is justified on grounds of economy in construction, because increased grade or slope means a progressive deepening from Chicago westward, until the volume of the wedge excavated would exceed the excavation involved in the Furthermore, the vechannel now under construction. locity in the earth sections must not be such as to cause erosion of the bottom or sides, an action apt to take place in sandy soil which may become soft by prolonged contact with water.

The whole question of comparative cost of channels of different depths and carrying widths was treated very exhaustively and presented to your Honorable Body in elaborate detail in December, 1892 (see report of the Chief Engineer, transmitting the results of computations made by Mr. T. T. Johnston, then First Principal Assistant Engineer, December 28, 1892, pages 966-70 of Proceedings). These tables are now in print, and accessible to all who wish to use them. A narrower and deeper channel would have been less costly than the one now being constructed, but the Sanitary District law fixed 160 feet as the minimum width, which limitation fixed the width in rock channel and the earth channel was made of dimensions giving a corresponding capacity.

Yours respectfully, (Signed) ISHAM RANDOLPH, Chief Engineer.'''

EXTRACTS FROM THE OFFICIAL PROCEEDINGS OF THE BOARD OF TRUSTEES, MARCH 22, 1899, CONTAINING THE MESSAGE OF WILLIAM BOLDENWECK PRESIDENT OF THE BOARD OF TRUSTEES TRANSMITTING TO THE BOARD LETTERS OF THE SECRETARY OF WAR AND FORWARDING PERMITS FOR IMPROVING THE CHICAGO RIVER.

Proceedings Sanitary District, 1899, pages 5581-5582.

"Message in Reference to Permits for Certain Construction Work.

President Boldenweck presented and the Clerk read a message transmitting, for printing and filing, letters from the Secretary of War in reference to permits for the construction of coffer-dam at Adams street, for the construction of temporary and permanent bridges, for the Chicago Terminal Transfer Railroad Co. and the construction of permanent bridge at Taylor street, which by unanimous consent was ordered received, printed and placed on file.

The following is

The Message:

To the Honorable the Board of Trustees of the Sanitary

District of Chicago: Gentlemen:

I transmit herewith to your Honorable Body, for printing in the proceedings and filing, letters enclosing permits granted by the Hon. R. A. Alger, Secretary of War,

for the construction of coffer-dam at Adams street, for the construction of temporary and permanent bridge for the Chicago Terminal Transfer Railroad Company, and the construction of permanent bridge at Taylor street. Respectfully submitted,

(Signed) WILLIAM BOLDENWECK,

President.

(3 enclosures.)
The following are

The Letters.

'War Department, Washington, November 30, 1898.

Sid:

Referring to your application of 12th inst., I have the honor to transmit herewith an instrument granting permission to the Board of Trustees of the Sanitary District of Chicago to construct a temporary coffer-dam around the east side of the center pier of Adams street bridge in Chicago River, at Chicago, Illinois, and to deposit clay outside the coffer-dam running north and south from center pier and extending into the bank, upon the conditions set forth in said instrument.

Very respectfully, (Signed.)

R. A. ALGER, Secretary of War.'

Mr. William Boldenweck,
President, the Sanitary District of Chicago,
Security Building,
Chicago, Illinois.
(Inclosure: Instrument-2 of 8302)

'War Department, Washington, January 13, 1899.

Sir:

Referring to your application of 16th ultimo., I have the honor to transmit herewith an instrument approving the location and plans of a permanent and a temporary bridge to be constructed by the Sanitary District of Chicago over the south branch of the Chicago River, at Chicago, Illinois.

Very respectfully, (Signed) R. A. Alger, Secretary of War. Mr. William Boldenweck,

President of the Sanitary District of Chicago, Security Building, Chicago, Ill. (Inclosure: Instrument-1 of 8887)

> 'War Department, Washington, March 10, 1899.

Sir:

Referring to your application of 27th ultimo., I have the honor to transmit herewith an instrument approving the map of location and plans of a bridge to be constructed by the Sanitary District of Chicago across the South Branch of the Chicago River, at Taylor street, Chicago, Illinois, to replace the existing bridge at this point.

> Very respectfully, (Signed.) R. A. Alger, Secretary of War.'

Mr. William Boldenweck,
President, the Sanitary District of Chicago,
Security Building,
Chicago, Illinois.
(Inclosure: Instrument-2 of 1394.)"

EXTRACT FROM THE ANNUAL REPORT OF CHIEF OF ENGINEERS, UNITED STATES ARMY, PART 3, APPENDIX J. J., PP. 2550-2556.

The above appendix consists of the report of Capt. W. L. Marshall, United Engineer at Chicago, July 11, 1890, pages 2550 to 2556. Major Marshall inserts the Act of May 29 1889, entitled "An Act to create sanitary districts and to remove obstructions in the Desplaines and Illinois Rivers." The Act is set out in full, Sections 1 to 27, inclusive.

The Act is set out in full, together with amendments, as "Exhibit A" of the answer filed by the Sanitary District and therefore not recopied at this place.

EXTRACT FROM THE REPORT OF CHIEF OF ENGINEERS, UNITED STATES ARMY, 1890, PART 3, APPENDIX J. J., PAGES 2556-7.

Being an act to provide for the improvement of the Illinois and Desplaines rivers passed by the Legislature of Illinois and approved June 4, 1889, commonly called the "Little Waterways Bill."

United States. Improvement of the Illinois and Desplaines Rivers.

Section.

Repeal.
 Works ceded to the United States on condition.

Conditions—removal of dam.
 Basis of act of cession.

An Act in reference to the improvement of the Illinois and Desplaines rivers, and to repeal an act entitled "An Act to cede certain locks and dams in the Illinois River to the United States," approved May 31, 1887; in force May 31, 1887. Approved June 4, 1889, in force July 1, 1889.

18. Repeal.) § 1. Be it enacted by the People of the State of Illinois represented in the General Assembly, That an act entitled, "An Act to cede certain locks and dams in the Illinois River to the United States," approved May 31, 1887, in force May 31, 1887, and ceding the State works at Henry and Copperas Creek, and the pools created by said works, to the General Government upon certain conditions as to the opening of a waterway of a depth of seven feet from the Mississippi River to Lake Michigan, upon plans to be determined by the United States engineers, is hereby repealed.

19. Works ceded to the United States on condition.) § 2. That the State works at Henry and Copperas Creek, and the river now slackwatered by said works, are hereby ceded to the United States, on condition that the dams shall be removed whenever the depth now available for navigation can be secured and maintained by channel improvement without the aid of said dams: Provided, That said depth shall be assured upon the removal of said dams, or that such removal

shall not materially impair navigation.

20. Conditions—removal of dam.) § 3. That in the event of the non-acceptance of these works upon the conditions mentioned in section 2, within four (4) years after this act becomes a law, the Canal Commissioners of the State of Illinois are authorized and instructed to remove the dams at

Henry and Copperas Creek.

21. Basis of act of cession.) § 4. That the State of Illinois bases this act of cession upon the condition that the plan of improving the Illinois River below La Salle by slackwater maintained by dams and locks, be changed to a plan of improvement by means of an open channel in conjunction with a water supply from Lake Michigan.

JOINT RESOLUTION.

Whereas the present addition to the low-water volume of the Illinois River through the summit level of the Illinois and Michigan Canal from Lake Michigan more than doubles the volume of water used in the estimate of 1868 for the channel below Peru, and adds 50 per cent. to the volume used in the estimate of 1880 for the channel below Copperas Creek and said contribution from Lake Michigan will be increased in the immediate future, thus enabling the depth now projected for navigation below Peru to be obtained by channel improvement at moderate cost, and with decided advantage to material interests and to healthfulness along the valley.

Whereas it is contemplated to increase the volume from Lake Michigan to 300,000 cubic feet per minute within a few years, and ultimately to add 600,000 cubic feet or more, thus enabling a large depth for navigation to be obtained by an improved channel, and that said channel will be self-sustaining and self-improving and will discharge flood waters more readily, thus benefiting the bordering lands and increas-

inf the healthfulness of the valleys.

Whereas works now projected by the City of Chicago will form part of a waterway of large proportions from Lake Michigan via the Desplaines and Illinois rivers to the Mississippi River, of which the dams and locks upon the alluvial section of the Illinois River, can form no part, and which, if allowed to remain, will increase, overflow and be detrimental to the welfare of the Illinois Valley and the interests of

the State: Therefore be it Resolved.

By the Senate of the House of Representatives concurring herein (1) That it is the policy of the State of Illinois to procure the construction of a waterway of the greatest practicable depth and usefulness for navigation from Lake Michigan via the Desplaines and Illinois rivers to the Mississippi River and to encourage the construction of feeders thereto of like proportions and usefulness. (2) That the United States is hereby requested to stop work upon the locks and dams at La Grange and at Kampsville, and to apply all funds available and future appropriations to the improvement of the channel from La Salle to the mouth with a view to such a depth as will be of present utility and in such manner as to develop progressively all the depth practicable by the aid of a large water supply from Lake Michigan at Chicago. the United States is requested to aid in the construction of a channel not less than 160 feet wide and 22 feet deep with such a grade as to give a velocity of 3 miles per hour from

Lake Michigan at Chicago to Lake Joliet, a pool of the Desplaines river, immediately below Joliet, and to project a channel of similar capacity and not less than 14 feet deep from Lake Joliet to La Salle all to be designed in such manner as to permit future development to a greater capacity.

Chief of Engineers Reports, 1890, part 3, Appendix J. J.,

pages 2556-2557.

EXTRACT FROM REPORT OF CHIEF OF ENGINEERS, UNITED STATES ARMY, 1890, PART 3, APPENDIX J. J., PAGES 2557-2574.

Same being a preliminary report of the Drainage Water Supply Commission of the City of Chicago, dated January, 1887, signed by Rudolph Hering, Chief Engineer, Benezette Williams, and Samuel G. Artingstall, Consulting Engineer. The above report was copied into the record at the direction of the United States District Attorney, James H. Wilkerson, on the cross-examination of Rudolph Hering and is found on transcript, page 831, abstract, volume I, page 496.

EXTRACT FROM THE REPORT OF CHIEF OF ENGINEERS, 1891, APPENDIX M. M., BEING REPORT OF CAPT. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO, JULY 10, 1891, TRANSMITTING THE PRELIMINARY REPORT OF W. E. WORTHEN, CHIEF ENGINEER, JOHN NEWTON, CONSULTING ENGINEER OF THE BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO. Pages 2617-2618:

"Preliminary Report of W. E. Worthen, Chief Engineer, and John Newton, Consulting Engineer, to Board of Trustees of Sanitary District of Chicago, on Feasible Routes for Drainage Channel from Chicago to Joliet. We have the honor to submit a preliminary report, with a map, showing certain feasible routes for the proposed

drainage channel from Chicago to Joliet.

The dimensions of the drainage channel have been described by the act 'to create sanitary districts and remove obstructions in the Desplaines and the Illinois

Rivers,' etc. (Section 208.)

This act provides that the drainage channel 'shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be of a depth of not less than 14 feet, and a current not exceeding 3 miles per hour, and if any portion of any such channel shall be cut through a territory with rocky stratum

where such territory with rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than 18 feet, such portion of such channel shall have double the flowing capacity before provided for, and a width of not less than 160 feet at the bottom, capable of producing the depth of not less than 18 feet of water.

DESCRIPTION OF NEW ROUTES AND ESTIMATES.

Of all the new routes that have been surveyed, plotted, profiled, cross-sectioned, and estimated, two only have been selected for comparison—those marked on plan in full line "D." We think the former to be the better, as it is somewhat less expensive, and it provides at the same time for carrying off the storm water of the Upper Desplaines without the necessity of constructing expensive cut-offs from the Desplaines to the lake north of Chicago. In this view the channels estimated and designed for the maximum flow of 600,000 cubic feet per minute will suffice and with the gate cut-off in the Ogden ditch line, somewhere in the west fork of South Branch, will prevent the high water of the Desplaines flowing back into the Chicago River.

APPROXIMATE ESTIMATES.

We estimate the total cost of entire line of 18 feet water depth by way of Ogden ditch at \$25,700,000.

If the excavation in earth be reduced to 14 feet water depth and the side rubble walls be omitted, we estimate

the cost at \$22,700,000.

If the difference between 14 feet and the maximum depth provided by law is ever to be taken out it could be much more cheaply done when the channel is dry than by dredging after the water has been let in. Most of the work in the excavation and transfer of material must be done by machinery, and under a thorough system, with the best modern appliances, ample space for the piling up of waste, and ready removal by rail, the channel should be completed in 4 years.

Between Bridgeport and Willow Springs there will be 17,526,000 cubic yards of waste material if the water depth is 18 feet, and 14,656,000 if the water depth is 14

feet.

Between Willow Springs and the Joliet Basin there will be 3,500,000 cubic yards of earth excavation, 3,537,000

cubic yards of hardpan excavation and 13,351,830 cubic yards of rock excavation.

Between Willow Springs and the Joliet Basin there will be 18,948,600 cubic yards of waste material, of which

13,351,830 cubic yards are rock.

How far earth and rock may be found to be of marketable or other value we leave to experts; but it would seem that the rock has already a market, and it could be stored on the banks while waiting disposal.

The dimensions of the section of the channel are shown in the drawing, being an average width of 180 feet, with nearly vertical sides, and the depth of 18 feet below

the flow line of water.

A route following the line of canal is feasible, but it must be considered that the canal is already a part of a drainage system, and cannot at present be dispensed with. To attempt to convert it, while thus used, into the main channel of the new system would be attended with great

difficulty and cost.

Although not urgently required until the completion of the system, we have considered it expedient at this time, with the view of eventually securing an ample supply of lake water, to call attention to the necessity of straightening, widening and dredging in certain places the Chicago River and its branches, and of increasing the discharge of pumps at Fullerton avenue. That discharge now averages 12,000 feet per minute, and it should be increased to 30,000 at the lowest. Provision must be made also for conveying a supply of fresh water into the east and west arms of the south fork, and for carrying off the diluted contents.

The law provides for the new drainage channel to terminate at the upper basin at Joliet. The addition of 300,000 cubic feet per minute, the usual estimated flow of channel, will drown out Locks 5 and 6. Consequently some adequate means must be devised to dispose of the discharge of the channel at that place, so that property, persons and health in the Illinois River Valley shall not

be endangered.

From the termination of the channel at Joliet to a point above the Sag, rock excavation could be advertised as soon as the title to the lands is secured. It is proposed, first, to cut a longitudinal trench—a part of the channel—through the rock in that portion of the route just described. The trench thus excavated will

save much in pumping and in plant, and its completion will constitute an important progress in the execution of the whole system. In fact, to effect the drainage of the whole work during the progress of excavation, the lower portion, toward Joliet, would naturally be first undertaken.

W. E. Worthen,

Chief Engineer.

John Newton,

Consulting Engineer.

To the Honorable Board of Trustees of the Sanitary District of Chicago, January 13, 1891."

REPORT OF CAPT. W. L. MARSHALL, JUNE 10, 1891, TRANSMITTING TO THE SECRETARY OF WAR REPORT OF S. G. ARTINGSTALL, CHIEF ENGINEER TO THE BOARD OF TRUSTEES OF THE SANITARY DISTRICT ON THE CHEMICAL ANALYSIS OF SEWAGE.

Pages 2622-23:

"Report of Samuel G. Artinsgstall, Chief Engineer to Board of Trustees of the Sanitary District of Chicago, on Results of Chemical Analysis of Sewage Taken from Chicago River and Branches.

Gentlemen:

Herewith find the mean results of 133 samples of sewage taken from the Chicago River and its branches and analyzed by Prof. J. H. Long. The original reports of each sample are in the possession of this department. Yours respectfully,

Samuel G. Artingstall, Chief Engineer.

The Honorable Board of Trustees of the Sanitary District of Chicago. May 20, 1891."

MEANS OF ANALYSES OF SEWACE SAMPLES (RESULTS GIVEN IN PARTS PER MILLION).
(BY PROFESSOR 1. H. LONG.)

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REPORT OF CHIEF OF ENGINEERS UNITED STATES ABMY, 1892, PART 3, APP. J. J., BEING THE REPORT OF CAPT. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO, AUGUST 18, 1892, TRANSMITTING TO THE SECRETARY OF WAR COMMUNICATION OF MR. FRANK WENTER TO THE BOARD OF TRUSTEES OF THE SANITARY DISTRICT OF CHICAGO, APRIL 21, 1891.

Pages 2270-2273.

"Communication to the Board of Trustees of the Chicago Sanitary District, Submitted by Mr. Wenter, Mem-

ber of the Board, April 21, 1891.

Memoranda in relation to main outlet, Sanitary District of Chicago. These memoranda relate to the following topics: (1) The Worthen-Newton estimate; (2) prices for work; (3) estimate for various channels; (4) capacity for dilution of sewage; (5) available revenue; (6) large expenditures by cities.

They are presented as a series of notes for the purpose of showing that the sanitary works called for by the law are within the resources of the community and

are necessary.

1. THE WORTHEN NEWTON ESTIMATES.

Their channel followed the Ogden-Wentworth ditch and the west bank of the Desplaines River. The dimensions were 180 feet wide and 18 feet deep with a grade of 5 inches per mile. The estimate of cost was \$25,700,000, not including land damages or passages of the water

through Joliet.

Their estimate is excessive and for the following reasons: (1) The location follows higher ground than is necessary; (2) the route covers more work than any other line that can be considered; (3) the proportions of the channel are not the best for economy; (4) unnecessary retaining walls are provided; (5) the prices for work are nearly double those for which this work can be done, as compared with other works of the world.

In addition, it may be stated that the location is not well suited to the needs of the city, and the better and less expensive channel can be made for navigation.

The following table compares the prices used with those adopted by the Hering Commission of 1886-7, consisting of Rudolph Hering, Benezette Williams and S. G. Artingstall.

Price Per Yard.

Class.	Worthen Newton	Hering Commission
Rock	. \$1.20	\$.75
Hardpan, etc	60	.30
Clay	30	.15

The prices for work were carefully considered by the Hering Commission, and the data in regard to extensive works, since gathered, sustain those prices as sufficiently liberal.

2. PRICES FOR WORK.

Solid rock in narrow railway cuttings, where disposal of material is difficult, is now being done at 70 to 90 cents

per yard.

Rock is now being quarried at Lemont for \$2.00 per cord of 13,000 pounds, or one hundred cubic feet solid. This is a rate of 54 cents per yard. It is delivered on board cars for \$1.08 per yard and has actually been delivered in this city for \$1.62 per yard, or \$6.00 per cord.

Rock for wharves on the Mississippi River is actually delivered on board barges for 50 to 75 cents per loose

yard for quarries on the banks of rivers.

In the Amsterdam Canal at Holland (1865-76) 21,000,000 yards of material were moved at an average rate of about 4 cents per yard. In the St. Petersburg Canal (1878-85) 63,000,000 yards were moved for about 5 cents per yard. The St. Lawrence has been deepened over a length of 40 miles between Montreal and Quebec from a depth of 10½ feet to 27½ feet; material, clay, sand, hardpan, bowlders and some ledge rock; aggregate cost for last ten years' work, 13 cents per yard. The clay has been done at from 3 to 6 cents per yard.

The records of several dredges on harbor works in Europe and Australia give rates of from 4 to 6 cents per yard

in free material and at American prices.

The Lake Erie and Ohio River Ship Canal Commissioners of Pennsylvania recently reported on a canal 100 miles long from Conneaut on Lake Erie to Beaver on the Ohio River. Total excavation, 43,282,475 yards, at \$8,656,495, or an average of 20 cents per yard for all classes of material. Much of the work was estimated at 12 cents per yard.

The Manchester Ship Canal involves 47,250,000 yards, one-sixth of which is rock. Total cost of canal, complete,

\$30,000,000. Less than half of this amount is for excava-

tion, but the figures are not reported.

The North Sea (Holstein) Canal involves 67,000,000 yards of excavation, and the total cost is estimated at \$39,000,000. No details as to cost of excavation are given. Various harbor work in the United States is being done

at 10 to 20 cents in limited quantities.

The information available indicates that with special machinery and full preparation the work can be done as cheaply as similar work has ever been done, or well inside the prices of the Hering Commission—viz., 15 cents for clay, 30 cents for difficult dredging and 75 cents for rock.

3. Estimate for Various Channels. Channel from Ash-

land Avenue to Lockport, 30 Miles.

Capacity			Per		
Minute	Width	Depth	Mile	Excavation	Cost of Ex-
Feet	Feet	Feet	Inches	Cubic Yards	cavation
210,000	160	10	6.84	22,196,000	\$ 9,917,000
300,000	160	10	15.60	32,231,000	15,817,000
300,000	160	14	4.44	22,882,000	9,721,500
600,000	160	18	7.00	29,685,000	13,136,000
600,000	160	21.6	3.62	29,086,000	12,263,000
600,000	200	18	4.00	30,169,000	14,931,400
600,000	180	18	5.00	37,914,830	14,228,900

Prices of rock, 75 cents; hard material, 30 cents; clay, 15 cents. All the estimates above are on the same basis as

to prices per yard.

Between Ashland avenue and Lockport right of way, bridging and miscellaneous will add \$5,000,000 to each of the foregoing estimates for the total. One million may be added for passing the volume of water from Lockport to Lake Joliet.

Below Joliet the entire value of landed property throughout the Illinois Valley is estimated at less than \$3,000,000. Any damage from overflow will be but a frac-

tion of this.

It will be noticed that a channel 10 feet deep for either 210,000 or 300,000 cubic feet is more expensive than one 14 feet deep. It will also be noticed that a channel to carry 600,000 cubic feet and 21.6 feet deep is cheaper than a channel 18 feet deep and of the same capacity. It will also be noticed that to double the capacity from 300,000 to 600,000 only adds \$2,541,500, or some 17 per cent., to the total between Chicago and Lockport.

The reason for these results are due to grade and its effect on the amount of rock excavation at the lower end of

the channel.

The best proportion of channel can only be told after full borings have been made. It will be noticed that the Hering Channel, with a width of 200 feet, cost little more than the Worthen-Newton channel, with a width of 180 feet. This estimate involves more rock than is since found to exist, and is accordingly high.

The actual channel is not likely to exceed these esti-

mates, as the actual rock is less than that assumed.

By comparing the quantities with the total for the Manchester Canal some ideas of outside limit of cost may be obtained. That work involves a vast amount of docking, bridging and locks and is greater than a channel 25 feet deep carried clear to Lake Joliet, complete with locks and revetment.

4. CAPACITY FOR DILUTION OF SEWAGE.

The best results of investigation up to the time the law was passed placed the dilution at 20,000 cubic feet for each 100,000 inhabitants, as needed for a sanitary condition, and the probable population at 3,000,000 in 25 years.

During the past season the canal carried about 50,000 cubic feet per minute up to December last. The amount of organic matter carried out by the canal at that time was about 250 tons per day. This was not far from the amount going into the South Fork alone at that time, and was probably less than one-fourth of the total organic waste produced by the city as sewage. This cannot be definitely known until a sanitary survey is carried over the city.

It may be stated that if all the sewage of the city was made tributary to the canal before decomposition had set in, then a volume of 200,000 cubic feet per minute sent out of the city would not improve the condition now

found to exist in the canal.

The provisions of the law do not require unnecessary dilution, and it may be wise to provide the full amount

of 600,000 cubic feet from the beginning.

No engineer of this Board, nor of any previous investigations, have recorded an opinion that the dilution mentioned is not required for a sanitary condition, and no engineer has said that with this dilution the Illinois river would be fit to drink.

5. AVAILABLE REVENUE.

Assume that the assessed valuation for 1891 will be \$220,000,000 and that the valuation increase at the rate of 5 per cent. each year, which is certainly a conservative estimate, at the end of ten years the valuation would be \$341,292,000. This would permit a bond issue of about \$17,000,000 in ten years, were it not limited in the law to \$15,000,000.

If these bonds are issued at the rate of \$1,500,000 per year for ten years, and the rate of taxation of one-half of 1 per cent. is applied, then the total realized during the ten years from bonds and taxation would be \$25,-535,000 after paying interest currently on bonds issued

at the rate of 4 per cent.

If one-twentieth of the bonds are retired each year by money from the tax levy, then the available revenue in ten years will be less, or about \$20,000,000 to \$22,000,000, according to the magnitudes of the annual issues and the fiscal policy which may be adopted.

It is well not to lose sight of other sources of revenue which may be made available on a broad range policy.

Special assessment will be available for lateral channels, which seem a local territory, and perhaps to a limited extent on the main channel.

Property values may be created by applying the material excavated. The possibility of large resources

are covered in this.

3. Co-operation on the part of the United States. This

seems to have been lost sight of.

The dockage and water power will be sources of revenue in time, though this may be of slow development.

It is impracticable to construct an economical channel for drainage which is not also a good navigable channel. and the United States should be willing to put into this the cost of the 8-foot channel which its officers have estimated and recommended.

A practical fiscal policy should be possible under this law, and relief can never be had sooner than by making

a beginning.

The sanitary project of this city is a necessity, and well-considered investigation had determined that the ship canal solution is the only one practicable and within the financial resources of this city. The problem must be solved or this city must stop growing.

6. LARGE CITY EXPENDITURES.

Cincinnati put from \$25,000,000 to \$30,000,000 into the Cincinnati Railway. So far as direct revenue is concerned, the capital is largely sunk, though indirectly the city is richly repaid.

Chicago has put the same amount in her park system since 1869, and has not felt the burden, nor does she be-

grudge the expenditure.

This city expends about \$25,000,000 each year for all purposes, including the money for special assessments. (See last city report.) This is as much as it may ever be necessary to raise under this law and is spread over a term of years.

Considering the sums spent by other cities for public works, the sanitary project at twice the cost ought not

to be regarded as serious."

Chief of Engineers' Report, 1892, Part 3, Appendix J. J., pages 2270-73.

EXTRACT FROM THE REPORT OF CAPT. MARSHALL, SUPRA, TRANS-MITTING TO THE SECRETARY OF WAR REPORT OF THE COMMIT-THE ON ENGINEERING OF THE SANITARY DISTRICT OF CHICAGO TO THE BOARD, JANUARY 9, 1892.

"Report of Committee on Engineering to Board of Trustees of the Sanitary District of Chicago, Submitted January 9, 1892.

Gentlemen: On December 12, 1891 (page 298 of proceedings), your honorable board instructed the engineer-

ing committee as follows:

Resolved, That the engineering committee be instructed to carefully examine the work of the engineering department and any proposed plan of operations and make such recommendations as will expedite the beginning of actual construction upon the main channel between Chicago and Joliet, and secure the completion of the entire channel at the earliest date and with the greatest economy, and that said committee report as soon as practicable.

This resolution calls for a comprehensive review of the work of the district and the formulation of a policy for the consideration of the board. The committee has made full use of the time at its disposal, and now submits a general report, reserving detailed recommenda-

tions for further consideration.

The committee has consulted maps, diagrams and reports, conferred with the chief engineer, heard experts upon the relative cost of rock excavation under water and by dry quarrying and listened to the objections offered to the Chicago end of the route as adopted, on behalf of the several railway corporations interested. In addition, each member has used every opportunity to inform himself upon the matter in hand.

PAST POLICY OF THE BOARD.

Your committee cannot ascertain from the records or by personal inquiry that the action of the board has been guided hertofore by a definite policy or a specific plan of operations. If so, it was not a matter of general information.

The following have appeared to the committee:

(1) The estimates of the engineer contemplated fixed bridges throughout the route from Chicago to Lockport. The requirement of swing bridges and a navigable channel was one not anticipated by the railways, as ap-

peared in the hearings by the committee.

(2) The channel of a capacity of 600,000 cubic feet per minute through the rock begins at Sag, when the law requires that it should begin at Willow Springs, five miles nearer Chicago. (See Section 23 in regard to 'ter-

ritory with a rocky stratum.')

(3) The dimensions of the channel, its depth at the starting point, and its grade, are not matters of official record, nor are the works proposed for the development of water power below Lockport. In fact, there are no proper records which indicate the plans of the board. So far as the committee can infer, one foot only is allowed for fall in a distance of seven miles from the lake through the river to the stockyards, and the grades are relatively much less than those adopted by Messrs. Worthen and Newton. It is extremely doubtful if the channel as designed will pass muster under Section 27 of the law.

(4) Every engineer of the board has suggested that work should begin on the rock cut, between Sag and Lockport, as the completion of this section requires the longest time and is a measure of the period when the entire work may be made available. Statements have been made which led to the inference that condemnation proceedings here would require one year. It has

been ascertained that they can be completed for prac-

tical purposes in sixty days.

(5) The attention of the board was largely concentrated on the work between the stockyards and the Desplaines River at Summit, a section that would have been useless for several years until the remainder of the work could be completed. It was intended to erect pumping works at Corwith, and it is inferred that pumping works were also to be erected at Summit to throw water into the Desplaines River, a purpose certainly contrary to the spirit of the law. The report of the engineering committee, July 11, 1891 (page 201 of proceedings), seems to contemplate this section as the only work prior to 1893.

The above, and all that has come to the attention of

the committee, is in harmony with the following:

That the work immediately contemplated was a channel by the most direct route from the South Fork to the Desplaines River, near the Ogden-Wentworth Dam, the lines as adopted, said channel to be spanned by fixed bridges and to be operated by pumping works to the capacity of the canal at Corwith, and similar works at the Desplaines River, the work to be completed during 1892-'93. No investment was to be made on the remainder of the work.

THE ROCK CUT.

As the estimated cost of fifteen miles of work, covering the rock cut between Willow Springs and Lockport, is about 80 per cent, of the entire cost of excavation between Chicago and Lockport, and as the time required to do this portion of the work is longer than that required for any other section, the committee has given this portion of the route special attention, as the progress here made is a measure of the time when the entire work may be made available.

The line adopted follows the course of the Desplaines River, and it was proposed to excavate the rock under water. The chief engineer asserted that no other location was feasible, and that, in any event, the rock could be excavated as cheaply under water as by dry quarrying. Upon diligent inquiry, he failed to adduce any experience in justification of his conclusions or in support of the price used in the estimate (\$1.10 per cubic yard), which

appeared to be entirely too low for the character of rock

(Niagara limestone), nor did it appear that the chief engineer had any experience of his own upon which to

base an opinion.

The committee was not prepared to accept these conclusions. The method proposed seemed liable to serious interruption by ice and flood and to be subject to every contingency, thus rendering very uncertain the time of completion and the cost, and the channel itself would be left in very irregular condition, thus seriously impeding the flow of water and necessitating a larger section to carry the requisite volume. It was doubted whether the method would be followed in actual practice, and it seemed probable that the work would be done better, quicker and more cheaply by dry quarrying during such months of the years as the cut could be maintained free from the waters of the river.

One the other hand, could a location be obtained capable of protection against the river and all surface water, except what fell directly from the clouds, and should the rock itself not be water-bearing to the extent of requiring a large outlay to maintain dry quarry pits, the work could be prosecuted continuously throughout the year and free from contingencies, thus greatly expediting the completion of the work and insuring the very lowest

prices.

The matter was of such grave import that the committee sought the advice of experts, and men of the widest experience cheerfully responded to the request of the committee either in person or by letter, as Gen. Charles Fitz Simons, the McArthur Brothers, John Dolese of Dolese & Shepard, Mr. Earnshaw, Mr. Merriman, Gen. O. M. Poe, U. S. Engineer Corps, of Detroit, and Dun-

bar & Son of Buffalo.

It was the unanimous opinion that when dry pits could be readily maintained the work could be done much cheaper and more expeditiously by dry quarrying, and that under such condition the work could be prosecuted throughout the year. Such testimony as was specific indicated that it could be done by this method for one-third to one-half the cost of under-water work. Such testimony as was given in regard to the rock lying between Sag and Lockport, and such other information as the committee has gathered, indicates that the amount of quarry water to contend with over these ten miles will be small, and not an item of moment in the cost of the work.

Over these five miles from Willow Springs to Sag the rock is relatively small in amount and overlaid with

drift, and no conclusion is offered at this time.

Your committee finds that between Sag and Lockport there is considerable latitude for the choice of a route that can be protected from surface water at comparatively small expense and that will afford ready drainage for any quarry water that may require pumping; and it is probable that such routes may be considered; the

total amounts of rock will not greatly differ.

The probable saving ranges in the millions, according to the method of work that may prove expedient and the contingenies involved in the present location, and the time required may be reduced and made an element of certainty. Your committee, therefore, urges an immediate reconsideration of this section of the route, and the preparation of plans for its protection from surface water.

THE RAILWAY OBJECTIONS.

In view of the determination of the board to make the channel available for navigation as required by law, the location adopted from the South Fork to Summit became a matter of serious moment to the railway corporations which must cross the same by means of swing bridges, and especially so in proximity to yards and junctions. The committee, therefore, gave three hearings, at which all the corporations interested were fully represented.

The route between Chicago and Lockport is crossed at eight points by ten distinct lines, belonging to six corporations, and seven of these points are within the first nine miles. The Santa Fe Railway is crossed four times, three crossings of the main line and one at the throat

of their large yard at Corwith.

On any route selected there will be railway crossings, and the number of these on alternate routes cannot be reduced below seven lines crossing at four points, to

eight lines crossing at six points.

The constructive cost of the first nine miles of feasible routes will not greatly differ, and the difference in cost of right of way will probably be far less than the variation in claims for railway damages, so this factor becomes of prime importance, except as it may be outweighed by considerations which pertain to the efficiency of the channel.

Your committee finds that the railways are not disposed in any way to needlessly embarrass the work. They regard a draw bridge as a serious matter and insist that such structures shall not be unnecessarily introduced in their lines and that they be located, if practicable, at such points as to occasion the minimum of inconvenience. The route adopted has been characterized as one that inflicts the maximum possibility of damage between the waters of the Chicago River and Summit. At Corwith the route crosses the throat of the main yard of the Santa Fe system, the canal and junction point of three railway lines, all in a short distance. The situation is capable of some amelioration. The Santa Fe Railway could be relocated for five miles to the north of the proposed channel between Corwith and Summit, thus avoiding two main-line crossings, but the position of the yards and junctions would not be materially modified. claimed that the value of this yard would be destroyed and a yard in some other locality necessitated, the entire cost of which would fall upon the district, an item in itself stated at over \$1,500,000. This situation may be avoided or bettered by a route to the south of the yards, by the Illinois and Michigan Canal, or by one to the north of the canal.

The crossing at Western avenue and Thirty-ninth street is only less serious. Here are encountered the tracks of the Northern Pacific (not yet laid), the Panhandle, and the Stockyards Company leading to their railway yard. It is a waiting point for trains, and bridges would seriously embarrass the business to the stockyards, as the point is now operated. The situation is capable of some amelioration, but not to the extent of reducing the point to the status of the main lines without radical rearrangement. This may be possible, but the situation must be met in any route from the South

Fork.

The route adopted as probably the most available from the South Fork to the vicinity of Summit, for the purpose of pumping works at the canal crossing and at the Desplaines River, and was not intended for navigation. It certainly could not have been more objectionably located for the latter purpose. It is suggested by the chief engineer that the West Fork, to the junction point near Crawford avenue, was to be utilized as the navigable connection with the Chicago River, but no record of

such intention is found in any report or proceeding, and this view is not in harmony with the estimates for fixed bridges over the entire route and with the channel of full

section carried through to the South Fork.

The whole question of a route at this end should be reconsidered. The constructive cost should be re-estimated, the right of way appraised, and the railway damages valued for each line that may be available. On any line that may be adopted the final determination of the basis of railway compensation is likely to be a matter of tedious litigation.

The cost is not, however, the only criterion. Within limits of cost, considerations which pertain to the efficiency of the channel and its adaptation to future needs should also govern. Some of these may be stated with-

out further argument at this time.

(1) The channel should effectively remove the sewage without expensive adjuncts and auxiliaries which require large expenditures for operation and maintenance, thus making the efficiency dependent on the whims of an annual appropriation bill.

(2) The plan should contemplate the easy development of the water supply in excess of the capacity of the Chicago River when the occasion therefor shall arise, as

contemplated by the law.

(3) All conditions should be avoided which will in any way militate against the fullest development of a navigable route from the lakes to the Mississippi, or the development of a deep-water harbor. While these are not issues immediately pending, they can not be ignored. The only feasible line for a waterway between the basin of the St. Lawrence and that of the Mississippi is by the Chicago divide, and the only hope for a waterway in this generation is through the operations of this district, and for this object we may confidently enlist the aid of the United States in proper time. The deep-harbor question may be best and most cheaply solved through the works of the district when the occasion therefor may arise.

Proper consideration has not been given to the Chicago end of the route, and for this purpose the matter should be given the most deliberate judgment. The committee has no fear that the completion of the work will thereby be delayed or its cost increased; in fact, such a course is likely to diminish the actual total of expenditure during

the period for which the bonds will be issued.

OTHER SECTIONS OF THE ROUTE.

Any changes in the location of the section of 10 miles lying in the Desplaines River valley, between Summit and Sag, will depend largely upon the changes made in the rock section below Sag, and in the Chicago end this side of Summit.

The line runs through material varying widely in character and subject to all the contingencies of the Desplaines River. The channel for the 5 miles below Willow Springs will be partly in rock and will be necessarily slow in execution. The committee has not given the attention to this section of the route which would warrant advice at this time, and especially as any changes will depend in some degree upon the action taken upon the

sections below and above.

The work necessary below Lockport is relatively small, not requiring a long time for its execution, though condemnation proceedings may be somewhat tedicus. The plans contemplate the development of water power. It is submitted that all rights in the premises will be guarded by securing the right of way, and that the plans for such development should be in accord with the future requirements of a navigable channel. The work below Lockport is pre-eminently a matter in which to enlist Federal cooperation, and before any necessity arises for treating this section ample time will be permitted to define the policy of the district in this regard.

The relations of the Chicago River system to the works of the district are not yet determined, and surveys will

be required for this purpose.

It is doubtful whether a velocity of over 1½ to 1½ miles per hour through the river can be tolerated with due regard to the interests of navigation or the stability of the channel, with so many necessary obstructions in piers and angles. Some 400,000 cubic feet per minute passed through the South Branch in the flood of 1887, but the velocity at local points was excessive and the water at Bridgeport stood some 4 feet above the lake.

The channel can be greatly improved at localities and probably made available for a volume of 300,000 cubic feet per minute, but beyond this the cost is likely to be so large as to make a channel in some other locality a measure of economy when the occasion therefor arises.

OUTLINE OF POLICY.

The policy of the district is governed by the time when the works as a whole may be made available and the financial operations by which this result may be achieved within the resources of the district and at the least cost.

The 10 miles of continuous rock cut between Sag and Lockport demands the longest time in execution. This will require one thousand actual working days, or four years, and work should begin in the next six months. The 5 miles from Willow Springs to Sag, in part rock, will be scarcely less tedious, and actual work should also begin this season. Other items will not add over 10 per cent. to the cost of excavation, so the preparation for work is not a serious matter. These two sections will include about 80 per cent. of the total cost for excavation between Chicago and Lockport.

The work from Chicago to Willow Springs, 14 miles, can be completed in 1896, if actually begun in force in the spring of 1894. The preparation of plant will require some time, and this should be put under way in 1893. The cost of excavating this section will be exceeded by cost of right of way and damages. The adjustment of all questions in issue at the Chicago end will require

considerable time.

The work below Lockport can be completed, if undertaken, in 1894, or early in 1895. The litigation here will involve some delays. The plans should be in harmony with future development for navigation. The water

power will be conserved in the right of way.

The work in the Chicago River can also await the latest date, though the plans for its development should be early matured, so that the new bridges built by the city and any changes made may conform to future requirements.

The general plan of operations outlined is calculated to make the shortest possible investment for the funds

prior to the actual completion of the work.

The cash now in the treasury (\$720,000) will cover the necessary cost of preparing the work from Willow Springs to Lockport, and the amount to be received in taxes during the year (\$1,050,000) will cover any work of construction that can be undertaken this season.

The amount required for the work outlined is not yet a subject of close estimate. The section from Willow Springs to Lockport will probably fall inside of \$11,000,000, and the section from Chicago to Willow Springs should not exceed \$7,000,000, much depending on the matter of damages, a total of \$18,000,000. Below Lockport \$1,000,000 may be sufficient for present consideration. The work in the Chicago River is an uncertain item, but certainly \$1,000,000 will greatly better the stream for the uses of the district and for navigation.

Through taxes, bonds, and special assessments not less than \$20,000,000 may be made available, so there is no present reason to suppose that the resources will be in-

adequate.

After the main works outlined are completed, any further development will come logically and progressively, without entertaining any serious financial question, provided the general plan is now properly matured.

RECOMMENDATIONS.

Your committee has the honor to recommend as follows:

1. Reconsider the route from Sag to Lockport at once and prepare plans for protecting the same from surface water, with a view to beginning work on this section at

the earliest practicable date.

The reconsideration of this section will require little if any field work prior to staking out the adopted line on the ground. It should be possible to adopt a new route and prepare plans for the same in sixty to ninety days, and actually begin work in June. Sufficient property can be acquired by that time.

2. Relocate the route where necessary between Willow Springs and Sag, with a view to beginning work this season. This may be done in sixty to ninety days after

the Sag-Lockport section.

3. Reconsider the whole question of route from Chicago to Willow Springs, in the light of present needs and the requirements for future development.

Provision for actual construction on this section should

be made not later than the latter part of 1893.

4. Reconsider the route and the treatment of the

problem below Lockport.

Litigation here may require one year. Work need not begin until early in 1895. Meantime the plans may be

matured in harmony with some plan for navigation with Federal co-operation.

5. Fix the conditions to be met through the Chicago River as soon as practicable, so that all structures and modification in dock line may conform to a general plan.

The city will doubtless co-operate in this policy so far as it is has occasion to deal with the river in the interests of navigation. The work will be fragmentary and may involve some tedious litigation, and any opportunity for correcting the river at localities should be availed of. The larger part of the work, however, may be postponed should financial considerations render this expedient.

Your committee is persuaded that every energy should be bent to secure the actual beginning of work between Sag and Lockport, and that meantime every other consideration should be subsidiary. After this is begun ample time will be available for the careful consideration of other sections of the route, without delaying the completion of the work as a whole. We are also persuaded that such a course will apply the resources of the district to the best advantage.

CONCLUSION.

In view of some current misconceptions, your committee would add the following as bearing upon the character of the project as a whole:

(1) This solution of the sanitary problem was adopted because it was much the cheapest, involved little or nothing for maintenance and operation, and had collat-

eral advantages as a waterway.

(2) The capacity was fixed by two considerations:
(a) That the channel should provide the necessary dilution to maintain a sanitary condition for the probable growth of population during the time for which the bonds are issued, or until the work is paid for. (b) That it should be adequate, in conjunction with other works, to remove snow and rain water in flo ds, and thus prevent contamination of the lake at such times.

(3) It is not practicable, on account of excessive cost, to make a channel that will carry the requisite volume of water and at the same time be unnavigable. This is determined by the physical conditions. A channel flowing at a high velocity requires a high grade, thus increasing

the depth of rock-cutting at the lower end. Such a chan-

nel will be unstable in the clay.

(4) For the required capacity a deep channel is less costly than a wide one. It is also subject to less variation in flow, by changes in the level of the lake, by floods, and by ice, and it is more easily regulated at the lower end on account of less fall.

These are the substantial considerations which determined the present general plan as outlined in the law. Fortunately, all these conditions are also in the interest of navigation. The only incident for actual navigation is

proper railway and highway crossings.

This law was matured after long consideration, and is explicit in its provisions. It lays down the conditions which must be met, and definitely prescribes the limitations upon capacity and size of channel. It is no part of the duty of this board to question these provisions, and it has no option other than to carry them out in accordance with their full spirit.

Very respectfully submitted.

LYMAN E. COOLEY, WILLIAM BOLDENWECK, JOHN J. ALTPETER,

Committee on Engineering.

The honorable the Board of Trustees of the Sanitary District of Chicago."

Chief of Engineer's Report, Part 3, Appendix J. J., pages 2273-2278.

EXTRACT FROM REPORT OF CAPT. MARSHALL, SUPRA, TRANSMITTING TO THE SECRETARY OF WAR REPORT OF MR. WILLIAMS, CHIEF ENGINEER OF THE SANITARY DISTRICT OF CHICAGO, DATED FEBRUARY 17, 1892.

"Report of Mr. Williams, Chief Engineer, to the Board of Trustees of the Sanitary District of Chicago, Submitted February 17, 1892.

Chicago, February 17, 1892.

Gentlemen: On January 16 your honorable board

passed an order as follows:

'Resolved, That the chief engineer is hereby instructed to submit, as soon as practicable, alternative locations for the route between Sag and Lockport, with comparative estimates in sufficient detail to determine the rela-

tive cost of the several lines that may be considered, and that he include in said estimates all collateral works and

damages.

In complying with this order it is found that to make a proper preliminary location and estimate for alternate lines between the points named that will admit of the best method of treatment and be conformable to the sanitary district law involves a consideration of the work which will be necessary to improve, for the passage of water, the Desplaines River from some point above Lockport to the upper basin at Joliet and that which will be necessary in excavating the main channel between Sag and Willow Springs. I have hence exceeded the instructions to the extent of submitting alternative locations for the route between Willow Springs and the upper basin, with comparative estimates for quantities and cost for the whole distance, based upon the most econominal channel of uniform depth. Within these limits is comprised nearly all the rock excavation on the line of the proposed main drainage channel from Chicago to the upper basin.

Each of the several lines considered in the comparative estimates have received similar treatment, and the estimates are based upon the same method of working, except so far as differences of location compel varia-

tions.

There are three distinct routes from Willow Springs to Lockport and four from a point above Lemont to Lockport covered by these estimates. At or about Lockport all four lines merge into one. These various lines are shown upon the accompanying map, which is made in two sections, the estimates being given in Appendix A. The fifth line shown on the map is considered wholly as regards a different method of treatment and receives separate consideration hereinafter.

Line No. 1 follows the location made by Mr. William E. Worthen to a point above Lockport, where there is a deflection into a line common to all routes. This line is situated almost entirely on the north and west side of the Desplaines River, striking the river only at a very few

points.

Line No. 2 is on the location made by Mr. Samuel G. Artingstall, intersecting the common line at Lockport. It follows the bed of the river as closely as is consistent with a satisfactory alignment.

Line No. 3 is a new location throughout. As far as possible it lies on the south and east side of the Desplaines River, between the river and the Illinois and Michigan Canal. It necessarily crosses bends of the river in a few places, but in such a manner that with a comparatively small amount of excavation the river channel may be changed so as to protect the new work. It involves a new location of the Chicago, Santa Fe and California Railway for a distance of 22,200 feet, 6,000 feet of which the company is now engaged in making for the purpose of improving their line, leaving 16,200 feet to be changed should the route be adopted.

Line No. 4 and No. 4A are still other new locations; the former following line No. 3 to a point nearly 1½ miles above Lemont, where it diverges, crossing the Illinois and Michigan Canal one-half mile below Lemont, and again crossing the canal about 1 mile above Lockport. This line involves a shifting of the tracks of the Chicago and Alton Railroad near Romeo for a distance of 4,000 feet, and either the abandonment of the Illinois and Michigan Canal below the first crossing, or the carrying of that canal across the new channel in flumes, with

a waiver of the navigability of the latter.

No. 4A is a variation of line 4 lying between the two canal crossings. It does not differ materially from the

latter.

Line No. 5, as heretofore stated, is considered wholly with reference to a different treatment of the project from that proposed for lines 1, 2, 3, and 4. This difference of treatment is described in another place. This line starts at Willow Springs, coincident with line 2, and continues in that line a distance of 7,000 feet, thence in the same course to the west line of section 14, below Sag Junction, crossing the Illinois and Michigan Canal on the way, 31 miles below Willow Springs. Thence the line deflects northward into the Lemont tangent of the present canal produced; thence it follows the bed of the canal past Lemont, and continues in a straight course to the Romeo point, which it rounds with an easy curve, thence taking a straight course to Dam No. 1, at the lower end of the upper basin at Joliet. It follows close to line 4, east of the canal, and passes east of the wire mill at Lockport, and under the bridge of the Elgin, Joliet and Eastern Railroad. From Willow Springs to Dam

No. 1 there are but two curves, the whole distance being

accomplished by three tangents.

The adoption of this line will involve the reconstruction of the present canal in three sections aggregating a total distance of 26,000 feet. It involves two canal crossings, a change in the Chicago, Santa Fe and California Railroad for one-half mile, and a reconstruction of the Chicago, Alton and St. Louis Railroad in two sections aggregating in all 28,000 feet of double track. Like No. 4, it necessitates the abandonment of the Illinois and Michigan Canal, or the carrying of the same across the proposed new canal in flumes.

Within the range of the above described lines, almost the whole of the Desplaines River Valley is included, that can be said to be available for canal construction.

In the estimates of cost, given in Appendix A, for the first four lines that of the right of way has been excluded, except to state approximately the number of The results are peculiarly notable in the small variations that there is between the lowest and the highest, viz, No. 3 and No. 1, respectively, which is slightly less than 5 per cent. Indeed, this variation is so small that without considering the question of right of way, facilities for working which the various lines present and the probable hazard from floods in the Desplaines River, one would be in grave doubt as to which line to This doubt is still further increased when recommend. we consider that where the surface of the rock is overlaid with glacial drift, as it generally is from Willow Springs to Lemont, the profiles of the rock from which the estimates are made are not absolutely reliable, owing to the incompleteness of the borings, and that this unreliability exists probably to a greater extent with lines 3 and 4 than with either of the others.

Probably the surer and more conclusive way to arrive at a decision relative to these lines is by a process of

exclusion.

COMPARISON OF 3 AND 4.

Comparing No. 3 and No. 4 it is seen that the estimated cost of the latter line is \$271,752 greater than the former; the estimated cost of No. 3 being \$11,740,678.

No. 4 for a part of its length has some advantage in the matter of exposure to floods of the Desplaines River, but on the other hand is exposed to all drainage from the south of the line for several miles. It is also 1,000 feet shorter. It will require, in order to prevent damages by overflow, the condemnation of 435 acres of land more than No. 3. It crosses the canal twice, which will be an obstruction in working, and involves the raising, complicated questions with the canal commissioners, since the canal will either have to be abandoned or carried in flumes across the new channel. The estimates are based on the proposition to abandon the canal, as to carry it across the channels in flumes would defeat the purpose of the plan.

In this comparison it should be borne in mind that the doubt which exists as to the relative quantities for some of the lines does not exist as between these two, for the reason that throughout that portion of their length where they follow different routes surveys of the surface of the rock and of the ground have been carefully made. It is only in the section common to each that the profile of the rock is not reasonably reliable. Hence, as between these two lines, I have no hesitation in preferring No. 3.

COMPARISON OF 2 AND 3.

In comparing lines Nos. 2 and 3 it is seen that omitting right of way No. 3 is apparently \$140,966 cheaper than No. 2, and that it is 1,600 feet shorter. It is also much less hazardous in the matter of floods, and is likely to be less subject to water in the excavation during ordinary stages of the river. During the construction of line No. 2 the river will be forced into a new bed for a considerable part of the way, which will not be thoroughly puddled and comparatively water tight, as the old bed is. The levee that must be built along the new channel will for a large part of the way fall in the bed of the old river, and the land will slope toward it rather than from it, rendering it more difficult to exclude water. In some places also the river must be forced into very narrow confines between the new canal and the Chicago, Santa Fe and California Railway. Indeed, in at least one place, either the line or the road will have to be changed.

It has the advantage of saving 600 acres in right of way and in land subject to overflow, which, at \$100 per acre, makes it cost but little more than No. 3. Its alignment, however, is inferior, and if selected should be modified

in places.

A careful balancing of the arguments for and against each of these two lines makes it clear that line 3 is much to be preferred to line 2, though for reasons other than those shown in the estimates. Indeed, estimates are incapable of showing the real differences between lines under conditions such as these.

COMPARISON OF 1 AND 3.

The difference in cost between lines Nos. 1 and 3 is apparently \$539,375, omitting right of way. Line No. 1 is also 3,000 feet longer than No. 3. In the facility with which it can be protected from floods in the Desplaines River, line No. 1 is perhaps slightly superior to line 3; but it has the disadvantage of being on the north and west sides of the river, and hence exposed to the drainage from all the creeks and ravines and drainage areas tributary to the river. On the other hand, the canal protects line 3 by intercepting the drainage from the south and east, which would otherwise reach the new channel.

The lands which it will be necessary to condemn for line 3 are in excess of those for line 1 by 663 acres. Giving these lands an extravagant price will still leave the balance largely in favor of line 3. This line also has a better alignment than any that have been considered.

In thus analyzing the advantages and disadvantages of the several routes above described upon which estimates have been made, I am decidedly of the opinion that line No. 3 is the proper one to adopt for the main drainage channel.

The conclusion reached regarding the merits of the four lines under discussion stands independently of the manner of treating the problem after encountering the

sloping ground just above Lockport.

Though the comparison of cost has been made upon the basis of completed work in each case, from Willow Springs to the upper basin, the fact that all the lines merge into one at Lockport, the plan below being common to all, still leaves the relative showing correct for any treatment that may be given.

That there may be a full understanding of what this plan is, and its merits, if any, it is presented with two other projects that have heretofore been proposed, cover-

ing the length of about 23,000 feet lying between the end of the 18-foot channel, as proposed by the late Chief En-

gineer, and the upper basin.

Plan 1.—Mr. Worthen's plan was to continue the main channel with a uniform slope along the line shown on the map, to a point opposite the upper basin, and from this point the water was to pass through Joliet by means of a 24-foot steel pipe. In lieu of this the water could be allowed to escape into the upper basin and the river channel from the basin down improved to the proper capacity. If this plan were carried out, the upper or lake level would be maintained as far as the upper basin, and incidentally an excellent development of water power secured. On the west of the river valley would be the high level canal, and nearly parallel therewith and from 25 to 35 feet below it the river bed and the upper basin to act as a tail race.

Plan 2.—Mr. Artingstall's plan contemplates an improvement of the river bed by excavating and revetting the sides, and by building three dams, which will allow a descent in as many stages. This plan would allow of a partial utilization of the water power, but without extensive subsidiary canals would not give a full develop-

ment thereof.

Plan 3.—The present plan, the cost of which is given in the estimates, is to use sufficient of the waste excavation from the canal between Willow Springs and Lockport to build a water-tight bank 100 to 120 feet wide on top, from a point 9,000 feet above Lockport to the upper basin, confining the water between this bank and the high ground on the west side of the river. It is also proposed to waste a large amount of material on the west side of the channel formed by this embankment, and thereby limit the spread of the water. This plan will incidentally furnish as good a development of water power as it is possible to secure.

It is proposed to build this retaining bank to a height of 8 feet above datum and to let the water out into the upper basin through 5-foot cast-iron pipe sluices, controlled with gates. Such an arrangement will remove any possible chance of the bank being overflowed under the

worst conditions.

The general scheme as outlined on the map is quite preliminary and to a considerable extent nearly (merely?) suggestive; it cannot be worked out properly in detail until the territory covered by it has been surveyed.

Indeed, it should be said that in this matter of the terminal, below Lockport, there are modifications which can be made in the plan, and probably will be made on fuller study, which it is premature to enter into here.

A comparison of the cost of covering this stretch of 23,000 feet, by each of the three several plans described

is given in Appendix B.

The right of way required for plans 1 and 3 is the same, though it is impossible to state how much it is without considering the question with reference to the legal rights of the district to water power created by it. Plan 2 does not require so much land by about 670 acres.

In arriving at the results in Appendices A and B, it will be noticed that 11,000,000 yards waste is estimated as being hauled at 7 cents per cubic yard, and that 3,000,000 cubic yards of rock are allowed at a reduced price, and

credit given it in Appendix B, plan 3.

This waste enters into the bank that confines the water below Lockport, into a bank for the Elgin, Joliet and Eastern Railroad, and into spoil banks west of the proposed canal, thus raising the land and limiting the spread of the water.

As to the rate of 7 cents per cubic yard, due to the haul of the material from the excavation to the place of deposit, it should be said that it has been arrived at by very thorough investigations and estimates made by Assistant Engineer H. B. Alexander, the results of which are embodied in a report from Mr. Alexander, which I submit

herewith as Appendix C.

The rate is shown to be the difference in cost between wasting the material adjacent to the line of the canal, and hauling it into banks an average distance of 10 miles, full allowance being made for cost of track, equipment and operation. In regard to the cost of the road it should be said that the mere building of the roadbed without track and ballast is a part of the excavation of the canal, material from the channel being used to build the bank for the road. Such a bank, or something its equivalent, is necessary to protect the excavation from the floods in the river, so that the bank serves a double purpose.

The allowance of 10 cents per cubic yard on 3,000,000 cubic yards of rock is based on the theory that if all but this amount of the best quality of rock is permanently disposed of from the first, that contractors will be found, who in making bids will for the sake of owning this stone,

take the work at a very low price.

There are large quantities, running into hundreds of thousands of yards, of just such stone quarried and sold every year in and about Chicago, and there seems little doubt that the reason why this waste rock has heretofore been considered of no importance arises from the immense quantity which might belong to a great number of persons and thereby become valueless from its very plentifulness.

The incidental advantages which will be derived and the ultimate profits which may be reasonably expected to accrue from carrying out this plan, run up into millions of dollars. Some of these may be summed up as fol-

lows:

1. By permanently disposing of all but about 3,000,000 yards of rock, this amount will, as heretofore stated, be of value, and the contractor, who may own it after the work is done, can dispose of it at remunerative prices, for ballast, for crib work, and rubble masonry; and will doubtless in submitting a proposition to do so with this in view, making allowances to the benefit of the sanitary district. On the other hand, if the whole amount of rock is wasted, it will have little or no value to any one, as the market will be glutted with cheap stone.

2. As far as possible, it should be the policy of the sanitary district to so dispose of excavated material as to leave the banks clear of spoil. Much value will accrue to the right of way for the canal if it is kept clear of waste banks; but if it is encumbered with a chain of mountains on each side, its value will be almost destroyed. Four hundred feet of right of way clear will be of more

value than 800 feet cumbered with spoil.

3. By carrying out the proposed plan below Lockport a channel of full depth will be extended 4 miles further, and whatever the depth of the waterway which the United States Government may build to the Mississippi River, these 4 miles will be of great benefit, and, in dealing with Congress, as the sanitary district will ultimately do, it should receive recognition to the financial benefit of the district.

4. This plan furnishes means for the complete con-

trol and measurement of the water which passes down the river at all times, and will doubtless prove of great value in preventing actual damages in the river below in the time of excessive floods, and particularly in furnishing a check by which claims for fictitious damages may be met.

5. By carrying out this plan the sanitary district will own the best mill sites, and control the steadiest and most

reliable water power in the Northwest.

A fall of 33 feet, which will generally obtain 300,000 cubic feet per minute, will furnish 18,000 horse power, and with 600,000 cubic feet per minute it will furnish 36,000 horsepower. At the very low price of \$10 per horsepower, the first quantity when leased will bring an annual rental of \$180,000, which capitalized at 5 per cent. is \$3,600,000, while the greater quantity will capitalize at \$7,200,000. That this power would be readily taken at these rates admits of little doubt. It should be borne in mind that the execution of the proposed plan creates this power without another cent of expenditure other than short flumes and pipes to conduct the water to the wheels.

Line No. 5.—Surveys and estimates are being made of Line No. 5, the location of which is hereinbefore described.

The estimates, when completed will show the cost of

this line by two methods of treatment.

(1) The main channel proper will terminate at a point above the lower crossing of the Illinois and Michigan Canal, at which place controlling gates and waste flumes will be built. Below this point the channel will become a tailrace, and the water will be conducted to the lower basin in the cheapest manner consistent with safety.

(2) Parallel banks will be built—one on each side of the line below the lower crossing of the canal, and as far down as a point just above the Elgin, Joliet and Eastern Railroad bridge. There they will end in a cross-bank forming the inclosed space. At this point waste flumes and controlling gates will be provided for.

The banks of the channel will be carried up to a height of 8 feet above datum. This method will accomplish to a considerable extent the same ends accomplished by the plan heretofore described, and which is included in the

estimates for lines 1 to 4 exclusive.

Work was only begun on this line a few days ago, and as the results are not likely to affect the conclusions of this report in any way that cannot be properly considered by the engineering committee as a part of the same, it is thought best to submit the whole question in its present stage, and let the new data go to the engineering committee direct and be conveyed by that committee to the Board, rather than to delay another week.

Respectfully submitted,

BENEZETTE WILLIAMS, Chief Engineer.

The honorable the Board of Trustees of the Sanitary District of Chicago."

Chief of Engineers' Report, 1892, Part 3, Appendix J. J., pages 2278-2282.

EXTRACT FROM REPORT OF CAPT. MARSHALL, SUPRA, TRANSMITTING TO THE SECRETARY OF WAR REPORT OF MR. WILLIAMS, CHIEF ENGINEER TO THE SANITARY DISTRICT OF CHICAGO, MAY 4, 1892.

"Report of Mr. Williams, Chief Engineer, to the Board of Trustees of the Sanitary District of Chicago, submitted May 4, 1892.

Chicago, May 4, 1892.

Gentlemen: My communication of April 20, relative to a board of consulting engineers has been returned to me with the direction from your honorable board that I submit in writing at the next regular meeting the specific points which such board should consider.

It is true that the rules, technically construed, contemplate that all issues shall be defined and reduced to writing before the appointment of a board of experts; but as the opinion was entertained that it is fully within the powers of your board to engage experts to act in any capacity which you may see fit to prescribe, the request was made, expecting that if granted it would be upon broad grounds rather than in a manner strictly in compliance with the rules.

When the communication was submitted no issues had arisen that could be defined, nor can any such arise until the whole question is presented in the light of the bids which have been invited. The hope was indulged that by the choice of engineers of recognized standing and ability to consider the subject in all its bearings, it might

be possible to avoid all differences.

Though issues cannot be defined before they exist, it is not impossible to state the points about which they may cluster in certain contingencies.

As is well known, bids have been invited on three propositions, and a comparison of the same will be necessary

before awards can intelligently be made.

'Proposition 3' will give the cost of excavating and constructing the main channel complete, from Willow Springs to the upper basin at Joliet, waiving the right of way and a few collateral structures of relatively small

importance.

'Proposition 1' will give the cost of excavating, but in order to be comparable with Proposition 3, the cost of drainage and of the transportation of about two-thirds of the excavated material must be added. The determination of this additional cost is important, and any conclusion of your chief engineer relative thereto is not likely to receive universal assent.

'Proposition 2' will give the cost of excavating and disposing of a part, and only a part, of the material required to be excavated to furnish a channel for water to the upper basin. A tailrace, some 5 miles in length, will have to be located and excavated. Where shall this race be, and how much will it cost to excavate it? These are important points which your engineer can hardly hope to determine in such a manner as to be satisfactory to all.

Again, the work, if carried out in accordance with the proposed plan under either Propositions 1 or 3, will ultimately develop a water power above Joliet of fully 30,000 horse power, which will be utterly lost under Proposition 2. Will such a water power have any value, and if so, how much? And should it be considered at all in connection with the work of the sanitary district, however small its cost and however great its value?

By carrying out the work under either Proposition 1 or 3, a very large portion of the banks of the channel will be kept clear of spoil, while absolutely none will be left unincumbered under Proposition 2. Does any value

attach to this consideration?

A navigable channel under Propositions 1 and 3 will extend with deep water 5 miles farther than under Proposition 2. Such a channel, or its equivalent, is a necessity to the navigation of the Desplaines and Illinois rivers, and without it the money being expended by the

United States Government on the Hennepin Canal and the improvement of the Illinois River will be utterly thrown away. Should this receive any consideration in

carrying out this work?

Should it be shown that such a contribution to the work which the Government has in hand can be made at a nominal cost—work which would cost the Government, if carried out independently, many times what it would cost the sanitary district if done in connection with the main excavation—may it not be worthy of an effort to secure Government co-operation to the extent of the extra cost? And might not a thorough consideration of all these questions by a properly constituted board of engineers be the initiatory step to such co-operation?

These are mere hints as to the good which may come out of such a board if wisely chosen. But in view of the fact that the sanitary district is engaged in a work which incidentally is contributing immensely toward the project of a waterway which the Government is expending money upon, may it not be the proper time to take a step which may lead to results greatly to the financial benefit of the

sanitary district?

I am profoundly impressed with the importance of the questions which must be decided after the bids are received on the 8th of June—questions which it may appear will affect the interests of the sanitary district to the amount of several millions of dollars—and I believe that the only safe way to approach them is in the manner suggested. Should your honorable board reach the same conclusion, then I think that all unsettled questions connected with the work below Willow Springs, coming within the domain of the engineering department, should be referred to such board after your chief engineer shall have made a report upon the same.

Or what, as it seems to me, would be conductive to greater expedition and better results, the consulting engineers might act with the chief engineer in making a

joint report.

Respectfully submitted.

Benezette Williams, Chief Engineer.

The honorable the Board of Trustees of The Sanitary District of Chicago."

Chief of Engineers' Report, 1892, Part 2, Appendix J. J., pages 2282-2283.

EXTRACT FROM REPORT OF CHIEF OF ENGINEERS, UNITED STATES ARMY, 1893, PART 4, APPENDIX L. L., P. 2794, BEING THE REPORT OF CAPT. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO, DATED AUGUST 9, 1893, ENTITLED "IMPROVEMENT CHICAGO HARBOB, ILLINOIS, CAPT. MARSHALL STATES:

Chicago River.

The river and harbor act of July 13, 1892, in making appropriations for "improving harbor at Chicago," contained the mandate: "and the engineer in charge of the harbor is directed in his next report to submit what, if any, improvement should be made by the Government in Chicago River,

and the cost of same."

Without going into detail it may be said that this river, so far as navigable parts are concerned, is wholly within the limits of the City of Chicago and the County of Cook, State of Illinois. Originally it was a sluggish bayou or creek nearly stagnant for the greater part of the year, but in rainy seasons, when discharging not only water from its own watershed, but also a large quantity from Desplaines River passing over the low divide between its South Branch and the Desplaines River, it was, and still is, a rapid stream. At such times the large discharge kept scoured a natural channel varying from 8 ft. or less to 14 ft. or more in depth as far as to its mouth, where it was obstructed by a bar due to the antagenistic action of the river currents and lake storms and waves. This bar varied from 4 ft. or less to 9 or 10 ft. in submergence.

The stream is bifurcated, the north branch adjoining the south branch one mile or more above the mouth. The north branch is of greater natural length, but is not reinforced at flood from other low water drainage areas, and is of less natural depth and importance. The total length of main river

and branches is about 16 miles.

The United States about 1833 began improving the mouth of the river and the passage over the bar by constructing approximately parallel jetties to confine the discharge of the river at floods to definite widths of channel, and to prevent the influx of sands drifting under the influence of wind and wave, and by dredging across the inclosed parts of the bar to water in the lake suitable in depth to the navigation seeking this port.

As sands accumulated and vessels increased in draft the

piers on jetties have been extended, from time to time, farther into the lake, and as commerce by water increased, greater facilities for entering the river and sheltered harbors in Lake Michigan have been provided, as shown hereinbefore in the vicinity of the mouth of Chicago River, by the General Government. All works were completed in 1890 as hereinbefore shown.

From the inception of this great city to the present time the United States Government has restricted its work to providing a safe and free entrance to Chicago River by such constructions as have been required lakeward of the original

shore line of Lake Michigan.

Within the original shore line of Lake Michigan, which extended approximately along the present location of Pine street, the stream has been improved partly by the City of Chicago, but mainly by individual and corporate riparion owners for their own uses and gain, by dredging and constructing wooden bulkheads, or docks, sometimes within and sometimes without the original shore line or meander of the stream, as individual uses, fancies, or profit determined. These wooden bulkheads or limiting docks or wharves have been constructed without co-ordination or regard to the demands of navigation for non-obstructive angles and curves, and the results attained have been further modified and the capacity of the stream as a navigable waterway further limited by numerous bridges built in the same manner, i. e., without reference to any general plan in the interest of navigation.

Each bridge has been constructed seemingly without reference to the location of the bridges above and below it, in such situation as locally demanded by the growing necessities for intercommunication between the sections of the city separated from each other by the Chicago River and its branches. In many cases, where the cupidity or exigencies of corporations or individuals have demanded space, there has been extensive filling in within the original meander lines. There has been little regard paid of late to the marine interests, which has by encroachments by bridges and otherwise on the channel been hindered and harassed, and today the Chicago River is regarded by nine-tenths of its population not interested directly in its commerce as a nuisance to be abated, rather than as one of the indispensable arteries of commerce upon which is based the eminence among American cities attained by Chicago. This state of public opinion is due to the fact that the commerce by water of the City of Chicago is concentrated in comparatively few but wealthy

hands. The large elevators, coal and lumber yards, facilities for transfer from land to water transportation, and all the adjuncts of a great marine commerce, are in the hands of individuals and corporations embracing but comparatively few of the voting population of Chicago, who, as a mass, while without direct and apparent pecuniary interest in the marine commerce of the city, are daily incommoded and disgusted by this river. The inhabitants of Europe and the Northwest of the United States are more directly interested in the commerce of this river than are the citizens of Chi-

cago.

The matter of inconvenience arises from the necessity for opening the bridges for the passage of vessels and closing them for the passage of overland pedestrians and vehicles. The land traffic is enormous. Vessels, in number that has attained 22,000 in seven months seek passage. Ten to twelve millions of tons of freight must annually pass through the river and bridge spans over it in seven months. The bridges are crowded in the downtown districts when closed, with overland traffic; the draws of bridges jammed with vessels when open. The City of Chicago has exercised control over the movement of vessels and opening of bridges by the maintenance of a harbor master, and by ordinance regulating the movements of vessels and the opening and closing of the bridges. As far as they have not been constructed by corporate lines of overland communication the bridges have been constructed, and are owned and operated by the City of

With reference to the feeling of disgust entertained by the populace towards this stream, it must be said that from the earliest settlement of Chicago the most obvious disposal of their sewage and refuse, i. e., into the lake and river, has been followed. As the city grew, the old sewers were enlarged and additional ones built. The Illinois and Michigan Canal was constructed, and the contents of the river loaded with sewage was to a then sufficient degree pumped into it; later, this proved insufficient, and the canal was cut deeper to allow a flow by gravity towards the Mississippi River; this also proved in time inadequate, and it was required by the Illinois Legislature that sixty thousand cubic feet of water per minute should be pumped into the Illinois and Michigan Canal from the Chicago River to purify that stream. This requirement has never been attained. As far as ascertained, the discharge has never for any length of time for the past four years exceeded forty-five thousand cubic feet per min-

ute, and it is not believed to have averaged much, if any, above one-half the legal requirements, or thirty thousand cubic feet per minute. To purify the North Branch, pumping works and a tunnel from Lake Michigan to the North Branch at Fullerton avenue have been for years in use. Lake water is pumped through this tunnel and creates a feeble current towards the main river. This supply forms part of the thirty thousand to forty-five thousand cubic feet per minute pumped into the Illinois and Michigan Canal at Bridge-

port.

The insufficient discharge of the pumps into the canal results, in rainless weather in a very feeble current from the lake towards the pumps at Bridgeport, and in an indescribable state of putridity and offensiveness in Chicago River, due to domestic sewage and a discharge from manufacturing establishments through the sewers into the river. At ordinary rains, upon freshets in the Desplaines or Chicago rivers draining areas, great volumes of putrescent matter are disgorged into the lake through the mouth of Chicago river threatening the water supply of the city, which in the main is taken through tunnels under the bed of the lake from two inlet cribs, situate, one north of and the other south of, and a few miles distant from the mouth of the river.

To remedy the, at times, insupportable and disgusting condition of the river and its branches; to purify the river and to preserve the city water, relief is now sought under state laws by constructing a drainage canal from the south branch of Chicago river to the Desplaines river above Joliet, capable of discharging into the Illinois River Valley from three hundred thousand to six hundred thousand cubic feet of water

per minute.

It is a remarkable fact that this city, while seemingly unable or unwilling to provide funds for purifying Chicago river by pumping sixty thousand cubic feet per minute is ready to embark in, and has commenced the execution of a canal for discharging ten times that amount by gravity at a

comparatively enormous expense.

This channel has been located from the south branch of the Chicago River to Lockport, and is under construction, but no provision has yet been made for channels of supply from Lake Michigan. Whatever the outcome or plans of the local officials having this work in charge may be, it can be said that the Chicago River and its branches cannot in their present condition, supply materially more than from one-third to one-half of the minimum requirements of the law, without

producing currents that will be prohibitory to navigation at some of the bridges and obstructions now existing. It is certainly evident, granting the proposition that effective channels for the purpose will be constructed, that if this method of solving the drainage problem is to be carried to conclusion, there must be a complete remodeling of Chicago river throughout both its branches, and there must be also artificial channels of large capacity to furnish even approximately effective outfalls to the sewerage systems of a great city founded on low lands extending some twenty-two miles long, and for miles back from the lake, as well as other large feeders connecting the lake with such channels.

Without criticizing in any way the local measures taken for local relief, it may be said that the state laws, if effectively executed for the purposes specified, seemingly require changes in the capacity of Chicago River and its branches that may increase, may diminish, or may even entirely destroy their value for commercial purposes. In any case under existing laws, no alteration in the capacity of Chicago river can be made without the consent of the Secretary of War, or without full examination by agencies established by Congress, and the execution of the state laws are therefore

limited by superior authority.

As before said, the navigable channel of Chicago river is now maintained by the City of Chicago by dredging out the solid matter cast into it through sewers, and dumped into it, especially in winter, by its street cleaning department. The city also maintains bridge tenders, harbor master, and vessel dispatchers, patrols the stream with fire boats; pumps inefficiently the sewage from the river into the Illinois and Michigan canal; constructs and maintains all bridges except such as are necessary for corporate public carriers.

Riperian owners have constructed the docks and wharves, of which there are none for public use, and dredge for land-

ings alongside.

It is estimated that the total annual expenditure of the City of Chicago on the Chicago River is \$350,000, of which about \$120,000 is for dredging. This latter work is the only work than can be said to be in the interest of navigation.

The expenses for pumping of sewage, for bridges, for lighting and fire service, and other expenditures, are the necessary costs of encroachments upon this public highway to be paid by the profiting parties.

The dredging also is to remove solids and filth passed by the city into this navigable stream, contrary to the laws of the United States. It is necessary that either the law be enforced and the sewers sealed, or else awaiting a change of system which is not at all contemplated to require that solid matter necessarily placed in the river by the citizens of Chicago shall be removed by them before accumulating to such an extent as to obstruct navigation.

GENERAL REMARKS.

Chicago river is the most important navigable stream of its length on the globe. In the number of arrivals and departures of vessels annually it leads all harbors of the United States in tonnage it is second only to New York. In these elements it is the head of the great commerce of the lakes, but in capacity, depth, and width of navigation it is but a third-class port. Improvements are in progress along the chain of Great Lakes contemplating 20 to 21 feet depth of water at low water. Several harbors have 18 feet or more depth of channel. Chicago Harbor has 16 feet at entrance to the river, is obstructed by three tunnels with from 16 to 18 feet of water over their crowns, and can carry through but a comparatively small part of its navigable channel exceeding 15 feet. The entire inner harbor can be regarded as only a long private slip; there are no public wharves or docks, throughout its length, including branches; it is an offensive though navigable open sewer, obstructed by an average of four bridges to the mile, and lined for a greater part of its course by wooden docks in great part built up to the waters' edge by heavy buildings, elevators, etc., that will not admit a channel against them exceeding 16 to 18 feet without damage. The docks are generally of cheap construction of piles and sheet piles reaching but a few feet below the bottom of the channel existing when they were constructed but anchored back into the bank to other piles by iron tie rods about 1 and 1/2 to twice the channel depth in length. The docks are backed with earth. In many cases, as stated, over these cheap docks, but on foundations of additional tiles are constructed warehouses, etc., that may be more or less damaged by dredging close to the dock line to deepen the channel.

The river at numerous points, notably near Adams and Van Buren streets, has been contracted by filling within the mean-dered lines to less than one-half its original width. At other places in rebuilding docks, new docks have been constructed outside the first dock line. Abutments of bridges also project into the river, and piles or rip rap stone have been placed

in the stream to butress insufficient bulkheads or docks. Bends in the river now rigidly fixed by docks, of curvature with chords of sufficient length to allow the free passage of vessels of dimensions of twenty years ago, taken in connection with obstructive bridges prohibit passage by the largest modern vessels.

At the same time the increasing value of lands for other purposes near the mouth of the river is causing grain elevators, coal yards, lumber yards and manufacturing establishments, dependent upon marine transportation either to recede farther and farther from the mouth of the river, or to go elsewhere. Some establishments have moved to South Chicago, and Waukegan and Milwaukee have also profited at the ex-

pense of Chicago.

Consequent upon this recession vessels must pass an everincreasing number of obstacles in reaching places of transfer of cargoes. Tugs, often two of them to a vessel, must be employed in all movements of vessels in the river above the junction of the two branches, and it is averred by prominent vessel owners that the cost of moving one of the larger vessels from the lake to the elevators above Twenty-second street and returning it to the lake is one-half the cost of transferring the cargo from Chicago to Buffalo.

This excessive cost, due entirely to the obstructions in Chicago River, is shown by differential freights on coal and other heavy commodities to other harbors on the Great Lakes, comparing mileage and rates, against Chicago.

In the present condition of Chicago River no material widening or deepening of the channel can be effected without great expense. A large proportion of the docks or bulkheads must be constructed, and in some cases precautions are necessary to prevent damage to buildings if the water

is materially deepened against their foundations.

There should always be at least 2 feet of water between the bottoms of vessels and the crowns of tunnels to guard against damages to vessels by chance obstructions of small extent lodging temporarily over the rigid crowns. To secure 18 feet available water the three tunnels under the river should be lowered until there will be from 20 to 21 feet of water over their crowns. If the improvement be made on the basis of 18 feet and the use of Chicago River and its branches be conceded by the United States to the State of Illinois as a drainage channel, of the capacity indicated by the State law, the modifications therein must be radical and

costly whether the expense thereof be borne by the United

States or the city of Chicago.

Heretofore, under recent river and harbor acts, the United States Government has exercised a limited control over Chicago River. It has been simply a conservative control, the United States intervening only where encroachments prejudicial to the rights of the public in the navigation of Chicago River were in question. Plans for bridges across Chicago River have been acted upon by the Secretary of War, and at least one bridge, i. e., that bridge originally constructed at Canal street, has been condemned as an obstruction to navigation by the War Department and has been altered or changed by the city of Chicago upon the mandate of the Secretary of War, but not in exact accordance with that mandate either as to plan or time. The Secretary of War has not exercised his authority under the law to stop the deposit of filth in the river, nor interfered in any way with the regulations of the city with reference to the movement of vessels and bridges in or over the stream or with local police regulations relating to this stream.

In the opinion of the engineer officer in charge of this district, for the present awaiting developments of local plans under State authority, no improvement in Chicago River should be made by the General Government; nor any public funds be expended thereon so long as the city of Chicago uses it as a dumping ground for its filth and refuse of all kinds. The City should be required to remove all deposits made therein that tend to diminish its present navigable

capacity, or to cease depositing its sewage therein.

This disposition of its sewage and deposit is now a necessity to this city and it is not in accord with public policy to prevent it as long as the city continues to remove the solid residue. The United States should continue its control so far as to preserve the navigation of the river from injury.

It will soon be necessary for Congress to provide for the extension to Lake Michigan of the navigation established on the Illinois River below La Salle, and to determine to what extent, if at all, it will utilize for navigation the great channel now being cut by local authorities in the rock divide, separating Lake Michigan from the Mississippi Valley. The question is at hand and must be determined at some date not far in the future, whether the national highway will utilize this cut and Chicago River as part of this communication, or the Calumet River route in connection with this local channel, or otherwise. There are no other practicable routes.

If Chicago River be adopted (which is not, in the opinion of the officer in charge, in view of the rapid expansion in territorial area as well as in population of this city, advantageous to either the local population for drainage purposes or for the United States for navigation), material improvements in the Chicago River channel will be required, but as before stated, even if Chicago River be utilized, the most direct channel for navigation is not the channel demanded by the necessities for drainage by the city of Chicago. If navigable channel must be arranged to best subserve local purposes, it is evident that material modifications will be required in Chicago River that may properly demand other navigable inlets than the one already provided at the mouth of Chicago

It seems, therefore, that before making appropirations for the improvement of Chicago River, the question of the future uses of this stream should be settled, whether it shall continue to be as now simply a long slip or succession of private slips, docks and wharves, utilized indeed for interstate and foreign commerce, but mainly for private and corporate gain, and for the main sewer of a great urban community, or whether it shall constitute a connecting link under federal control between the navigation of the Great Lakes and that

of the Mississippi River and tributaries.

This opinion is given as required by the law of July 13, 1892, but for the information of Congress the following is re-

spectfully submitted:

To reasonably accommodate existing commerce without extensive changes in Chicago River and without reference to future developments, the following work would be in the in-

terest of commerce and navigation:

First: That the Chicago River from its mouth to the stock yards on the south branch and to Belmont avenue on the north branch as far as may be permitted by existing docks and wharves be dredged to admit passage by vessels drawing 16 feet of water.

Second. All encroachments on the stream by docks within the original meandered lines of the streams obstructive to navigation, as it exists today, should be removed at the expense of the encroaching parties, and obstructive bridges

be required altered or changed.

To admit the passage of the largest lake vessels drawing not exceeding 16 feet of water at load draft, with no changes in the dock lines beyond the obstructive abutments of bridges and projecting obstructive angles of docks, will require

1,200,000 cubic yards of dredging, approximately, and 8,000 linear feet of docking, at an expense of about \$700,000, first cost, with an annual charge for dredging of from \$80,000 to

\$120,000 to maintain the channel.

The cost of maintenance, for reasons stated above, should evidently be borne by the city of Chicago as long as sewage is emptied into the river and the United States should be released from all damages to property by reason of the improvement in Chicago River, as required on the Calumet River.

Should a discharge of 250,000 cubic feet per minute be required through the south branch and main river, wholesale modification of bridges, tunnels and docks, and a widening of the river at many points will be required, and deepening to at least 18 feet of water below Chicago city datum with a slope necessary for this discharge, will be required at an estimated cost of \$6,000,000, primarily, not including consequential damages, and an annual expenditure for maintenance of from \$60,000 to \$75,000.

Chief Engineer's Report, 1893, Part 4, Appendix L. L.,

Pages 2794 to 2801.

EXTRACT FROM THE CHIEF OF ENGINEERS REPORTS 1895, PART 4,
APPENDIX J J, P. 2715, BEING REPORT OF CAPT. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO IN CHARGE OF
CHICAGO RIVER AND ILLINOIS RIVER REFERRING TO THE IMPROVEMENT OF THE ILLINOIS RIVER. CAPT. MARSHALL SAYS:

"The city of Chicago expects to turn into the channel of the Illinois at some future time 5,000 cubic feet of Lake Michigan water per second; at some more remote period there may be 10,000 cubic feet per second, but not probably within a generation. By law it is now required to pump 1,000 cubic feet per second into that channel, so that we may expect 4,000 cubic feet per second additional discharge given to the Illinois River at low water. Discharge measurements on the Illinois show conclusively that this amount of water, or even the maximum discharge, will not produce a channel without dredging or without locks and dams equal in depth to that easily attained now at very small expense by completing the dredging required. Under any probable condition an equal or nearly equal amount of dredging will be required to give an equivalent channel in the Illinois River. The proposed discharge (5,000 cubic feet) will increase

the depth of water over the crest of the Kampsville dam at low water about 8 inches, and the depth over Six Mile Bar near the mouth of the Illinois but little if any more. A low-water channel 7 feet deep will exceed in depth very materially the low-water capacity of the Mississippi River, and there can be no rational demand for one of

greater capacity.

These facts were presented to the Chief of Engineers U. S. A., as far as relates to the Illinois River work, in a supplementary project dated June 11, 1895, and authority obtained to present to Congress in this report estimates for the additional work required, as follows: For 3,600,000 cubic yards dredging, at 12 cents, \$432,000. Deducting from this amount the balance of former estimate \$112,500, including \$35,000 appropriated August 17, 1895, leaves the amount by which the original estimate is deficient \$319,500, and the amount still to be appropriated \$397,000. To perform this work it will be necessary to construct a dredging plant and renew the hulls of the two dredges now owned by the United States.

At least four additional dredges, with the necessary

scows and tenders, will be necessary."

Chief of Engineers Report, Part 4, App. J J, pages 2715-2716.

EXTRACT FROM REPORT OF MAJ. W. L. MARSHAIL, U. S. ENGINEER AT CHICAGO, JULY 16, 1897, BEING APPENDIX II TO REPORT OF THE CHIEF OF ENGINEERS, 1897, PART 4, PAGE 2795, SAME BEING AN EXTRACT FROM A REPORT ENTITLED "IMPROVEMENT OF THE CHICAGO RIVER, ILLINOIS."

"The fact that Chicago River can accommodate vessels of 16 feet draft only, and for but a small part of its length can admit vessels not exceeding 325 feet length and 42 feet beam, when large modern vessels now being rapidly added to the fleets of the Great Lakes are 432 feet in length, 48 feet beam, and designed for a draft of water of 19 to 20 feet, is disquieting and hampering to all interests at Chicago dependent upon commerce by water, and the demand for better accommodations in Chicago River is growing in intensity.

No practical method of procedure to remove the obstructions to navigation has been proposed the authorities of the sanitary district have contracted for dredging the main river and South Branch from Lake Michigan to

the connection with the drainage canal to a depth of 20 feet (or more in places), and propose some increase in the capacity if the channel for discharge by widening between docks at a few narrow points, and some more important aids to navigation in widening at a few bridge draws; but these changes, as well as those proposed in the Report of 1893, and allowed to be made by the sundry civil act of June 4, 1897, are not in accord with the radical improvements demanded for the accomodation of the largest modern vessels."

Report of the War Department 1897, Chief of Engineers, Part 4, p. 2795, App. II, Report of Major Marshall.

EXTRACTS FROM CHIEF OF ENGINEERS REPORT, 1899, PART 4, APPENDIX K K, P. 2826, BEING THE REPORT OF MAJ. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO:

"Improvement of Chicago River, Illinois.

This river constitutes the inner harbor of Chicago, Ill. Its navigable parts lie wholly within the city limits of

Chicago.

In the annual report of the Chief of Engineers for 1893, page 2974, may be found a full report upon this stream and its needed improvement, and in his annual report for 1897, page 2793, a history of the improvement

and some detailed information as to the obstructions to navigation existing along its channels.

The present project was adopted by Congress in the river and harbor act of June 3, 1896, and modified by the sundry civil act of June 4, 1897. It contemplates dredging the river and its branches from the mouth of the river to the stock yards on the South Branch and to Belmont avenue on the North Branch, as far as may be admitted by existing docks and wharves, to allow passage by vessels drawing 16 feet of water; also to acquire title to and cut away certain obstructive bends and projecting docks that narrow and obstruct the channel.

Congress has not provided for maintaining the dredged channels, and at present rate of fill by deposits of filth the river in four or five years will require another rillion and three-quarters cubic yards of dredging to restore its present capacity. These conditions will be somewhat bettered after the opening of the Chicago Drainage Canal, as far as relates to the South Branch, but as the current

will be slack, all but light suspended matter will still be deposited in the channels. The condition in the North Branch will not be materially improved in this respect over the present."

Chief of Engineers Reports 1899, part 4, Appendix

KK, pages 2826-2827.

EXTRACTS FROM THE OFFICIAL PROCEEDINGS OF THE SANITARY DISTRICT, AUGUST 31, 1892, ON WHICH DATE PRESIDENT OF THE SANITARY DISTRICT, Mr. FRANK WENTER, TRANSMITTED TO THE BOARD CORRESPONDENCE BETWEEN CAPT. W. L. MARSHALL, UNITED STATES ENGINEER AT CHICAGO, DATED AUGUST 24, 1892, AND MR. WENTER'S REPLY TO THE SAME.

"Federal Relations.

The President presented a communication from Captain W. L. Marshall, U. S. A., with reference to federal aid in construction of the main channel, and also nis reply to the communication; and the same were read.

Mr. Eckhart, seconded by Mr. Boldenweck, moved that the communications be referred to the Committee on

Federal Relations.

The motion prevailed unanimously and it was so ordered.

The following are the communications:

'United States Engineers Office, Chicago, Aug. 24, 1892.

To the President Board of Trustees, Sanitary District of Chicago, Chicago, Ill.:

Sir-The river and harbor act of July 13, 1892, contains

the following provision:

"Improving harbor at Chicago, Illinois: Completing improvement, seventy-two thousand dollars; and the Engineer in charge of the harbor is directed, in his next report, to submit what, if any, improvement should be made by the Government, in Chicago River, and the cost of same."

Under this provision I have to report what work should be done by the United States, if any, on Chicago

River, and the probable cost thereof.

It has been my desire since the inception of the Chicago drainage scheme, to submit to Congress and have published in the Annual Reports of the Chief of Engineers, all official information emanating from your Hon

orable Body, more particularly engineering projects and reports bearing upon a navigable waterway between the great lakes and the Mississippi River, whether I agree

with your objects and conclusions or not.

I think that it is desirable in this connection that the views of your Honorable Body shall be submitted to Congress, and if it be agreable to you I would be glad to receive your views on the subject matter of the act of July 13th, 1892, and to submit the same, with my re-

port, to Congress.

If this course be not agreeable to your Honorable Body, I beg that you will so notify me. The matter of Federal cooperation with you must necessarily soon come up, but I can readily see that you may prefer to bring it up as a distinct proposition. Nevertheless, I should be glad to receive any information, memorandum or assistance from your point of view, in making my report, that may seem suitable or advisable at this time to you, or to your authorized engineers.

Very respectfully, (Signed) W. L. MARSHALL, Captain Corps of Engineers."

" 'Chicago, August 25, 1892. Capt. W. L. Marshall, U. S. Corps of Engineers, 134 Van

Buren St., Chicago:

Dear Sir-Your communication of the 24th is duly received. The entire matter will be submitted to our board at our next regular meeting, and will take such action as

we see proper.

I am personally very glad to note in your communication your good will towards the enterprise in which we are engaged, and I trust that the good feeling which exists will tend towards a proper solution of the question of a waterway from the Lakes to the Mississippi.

Yours very truly, (Signed) FRANK WENTER. President of the Board of Trustees."

Proceedings of the Sanitary District of Chicago, 1892, page 713.

EXTRACT FROM THE OFFICIAL PROCEEDINGS OF THE SANITABY DISTRICT, AT THE MEETING HELD ON MAY 24, 1893, AT WHICH TIME THE CLERK PRESENTED A LETTER DIRECTED TO FRANK WENTER, PRESIDENT OF THE BOARD OF TRUSTEES, SIGNED BY W. L. MARSHALL, MAY 23, 1893.

"United States Engineer on Filling of Chicago River,

The Clerk presented a communication (accompanied by five enclosures) directed to President Wenter, as the result of a conference, by Captain W. L. Marshall, Corps of Engineers, U. S. A., with reference to the encroachments on the Chicago River; and the communication was read.

Mr. Boldenweck, seconded by Mr. Cooley, moved that the communication be ordered printed, and with enclos-

ures, referred to the Committee on Engineering.

The motion prevailed unanimously, and the communication was ordered printed, and with enclosures, referred to the Committee on Engineering.

The following is the communication:

'United States Engineer Office, Chicago, Ill., May 23, 1893.

Hon. Frank Wenter, President Board of Trustees, Sani-

tary District of Chicago, Chicago, Ill.

Sir—I have to return herewith the tracing loaned me by you this afternoon, showing the encroachments upon the navigable channel of Chicago River, near Van Buren

street, which tracing I have had copied.

I have to say for the information of your Honorable Body, that however I may differ from the local authorities as to the methods adopted by them for the amelioration or care of their defective sewerage, and water supply, that I recognize their right and the authority and capacity of the commonwealth of Illinois and the municipality of Chicago to deal with their local matters in their own way, and that having declared their choice, United States officers shall place full faith and credence in their acts. This office then, as far as not called by law to express opinions, etc., shall work in accord with local laws to further rather than obstruct, their ends and objects, as expressed clearly by the laws of the locality.

As far as the obstructions to navigation in Chicago River are concerned, we will deal with them under United States laws, but in case these laws are silent, or where questions arise where under these laws things may be done that may not be done under state and local laws, the custom of this office has always been to respectfully suggest to the Secretary of War that no action be taken until the local authorities expressed their assent, and that in no case should a permit be granted by the War Department until it be shown that the authorities of the State of Illinois expressed their concurrence in such action.

I have to enclose herewith copies of some endorsements relating to this matter of the Pennsylvania Railroad Company filling in in this vicinity, made on the various applications of this road for authority to encroach

on the limits of the Chicago River.

I have to say that I desire the backing and co-operation of the Trustees of the Sanitary District of Chicago to prevent any encroachments whatever upon the present channel of Chicago River, and to express to the Trustees of the Sanitary District my disinclination to recommend to the Secretary of War any restriction by bridges, filling or otherwise upon the capacity of the Chicago River, except where imperatively demanded by the people of Chicago in crossing the river by bridges.

An examination of the locality in question will be made at the earliest practicable date, and if it be found that it comes within the purview of the instructions issued to the United States District Attorney to stop by injunction from an United States Court such encroachment this action will undoubtedly be taken on my application, by

the District Attorney.

rney.
Very respectfully,
(Signed) W. L. Marshall,
Captain, Corps of Engineers.'''

(Five enclosures)

Proceedings of the Sanitary District of Chicago, 1893, pages 1244-1245.

EXTRACT FROM THE OFFICIAL PROCEEDINGS OF THE SANITABY DISTRICT AT A MEETING HELD MAY 24, 1895, AT WHICH TIME THE CLERK PRESENTED A COMMUNICATION ADDRESSED TO PRESIDENT WENTER BY COL. O. M. POE, UNITED STATES ENGINEER AT CHICAGO, DATED MAY 22, 1895.

"REQUEST FOR INFORMATION IN EFFECT OF MAIN CHANNEL ON LAKE LEVELS,

The Clerk presented a communication, addressed to President Wenter, from Col. O. M. Poe, Corps of Engineers, U. S. A., requesting certain information with reference to the effect of the Main Channel on the levels of the Lakes, as set forth in the communication; and the communication was read.

Mr. Boldenweck, seconded by Mr. Eckhart, moved that the communication be ordered printed and referred to the Joint Committee on Engineering and Finance.

The motion prevailed unanimously, and the communi-

cation was ordered printed and so referred.

The following is the communication:

'United States Engineer Office, Chicago, Ill., May 22, 1895.

Hon. Frank Wenter, President of Board of Trustees, Sanitary District of Chicago, Chicago, Ill.:

Sir—The Board of Engineers appointed by direction of the Secretary of War to consider and report upon "the probable effect of the operation of the Chicago Drainage Canal upon the lake and harbor levels and upon the navigation of the Great Lakes and their connecting water ways" would be pleased to receive from your Honorable Board of Trustees any information or data bearing upon the subject submitted to us, and especially the following:

First—The conclusions arrived at from investigations made by your authority or by others as to the effects upon the levels of the great lakes by the operation of your Canal, including any mathematical analyses and discussions of the question from which these conclusions

have been arrived at.

Any references to printed discussions by titles, etc., will be very much appreciated if copies cannot be furnished.

Second-Description of the Canal, including dimen-

sions of wetted perimeter, slopes, and character of ma-

terial through which excavated.

Third—Whether any part of the inner harbor of Chicago, which includes Chicago River and its branches, will be utilized as part of the proposed Canal, and if so what amount of water you propose to take through these river channels.

Fourth—If Chicago River be utilized, what changes you propose to make in the navigable channels of the river, in dimensions, slopes and structures to adapt them to your purposes; and what additional channels of supply other than the main branch of the Chicago River; which is now the only evident connection between Lake Michigan and the proposed canal, your Board proposes to make.

In making these inquiries, the Board of Engineers consider that your Honorable Body is much interested in the solution of the questions submitted to us, and therefore desirous to aid as far as practicable in arriving at correct conclusions.

Any communications you may desire to make should be addressed to me at Detroit, Michigan.

Very respectfully,

Your obedient servant, (Signed) O. M. Poe, Colonel, Corps of Engineers.'"

Proceedings of the Sanitary District of Chicago, 1895, page 2653.

EXTRACT FROM THE OFFICIAL PROCEEDINGS OF THE SANITARY DISTRICT OF CHICAGO AT A MEETING HELD FEBRUARY 9, 1898, THE SAME BEING THE RESOLUTION PASSED BY THE BOARD OF TRUSTEES INVITING THE COMMITTEE OF CONGRESS TO INSPECT THE CHANNEL OF THE SANITARY DISTRICT AS THE GUESTS OF THE BOARD OF TRUSTEES.

"INVITATION TO CONGRESSIONAL COMMITTEE.

Mr. Wenter presented, and seconded by Mr. Eckhart,

moved the adoption of the following Resolution:

'Whereas, it is currently reported that the Committee on Rivers and Harbors of the National House of Representatives is going to make a tour of inspection at the various rivers and harbors in the west; and,

Whereas, The importance of the Chicago River and

Harbor is second to none in the United States and deserves the fullest attention and consideration on the part of said Committee; and,

Whereas, The Main Channel of the Sanitary District of Chicago is nearing its completion, and as such it is one of the connecting links of said Chicago River and

Harbor; therefore, be it

Resolved, That the President be authorized and directed to send an invitation, in the name of the Board of Trustees, to said Committee to inspect the Channel of the Sanitary District, and that said Committee be the guests of this Board while sojourning in the city.

On roll-call, on the motion for the adoption of the resolution, the vote stood: Yeas—Messrs. Boldenweck, Braden, Carter, Eckhart, Jones, Kelly, Mallette and

Wenter-eight. Nays-none.

Upon which result the President declared the motion

carried."

Proceedings of the Sanitary District of Chicago, 1898, pages 4553-4.

EXTRACT FROM THE OFFICIAL PROCREDINGS OF THE SANITARY DISTRICT AT A MEETING HELD FEBRUARY 24, 1898, SAME BEING THE REPORT OF MR. WENTER AS CHAIRMAN OF THE COMMITTEE ON FEDERAL RELATIONS AND REPORTED THAT THE INSPECTION OF THE SANITABY DISTRICT CHANNEL WAS MADE ON FEBRUARY 23, 1898:

"INSPECTION OF MAIN CHANNEL BY CONGRESSIONAL COM-MITTEE.

Mr. Wenter, Chairman of the Committee on Federal Relations, made a verbal report that the inspection of the Main Channel by the Committee on Rivers and Harbors of the National House of Representatives on February 23, 1898, had been made pursuant to the Resolution of February 9, 1898 (Page 4554 of the Proceedings), but that the Committee had not prepared a written report on the matter."

Proceedings of the Sanitary District of Chicago, 1898,

Page 4575.

EXTRACT FROM REPORT OF THE CHIEF OF ENGINEERS, 1900, PART 5, APPENDIX M. M., PAGES 3858-9, IS ALREADY IN EVIDENCE UNDER THE U. S. ENGINEERS' REPORTS, SUPRA, VOL. 4, PAGE 2183.

EXTRACT FROM PROCEEDINGS OF THE SANITABY DISTRICT OF CHI-CAGO AT A MEETING HELD JULY 11, 1900, AT WHICH TIME MR. WILLIAM BOLDENWECK, PRESIDENT OF THE SANITABY DISTRICT TRANSMITTED TO THE BOARD A LETTER SIGNED BY MAJ. J. H. WILLARD, U. S. ENGINEER AT CHICAGO, DATED JUNE 20, 1900:

"MESSAGE TRANSMITTING REPORT IN REFERENCE TO CURRENT IN CHICAGO RIVER.

The Clerk presented a message from the President transmitting the report of Major Willard, United States Engineer, in reference to the current in the Chicago River, due to the flow of the Drainage Canal, which, with accompanying report, was ordered printed and placed on file.

The following is the message:

'Chicago, July 9, 1900.

To the Honorable, The Board of Trustees of the Sani-

tary District of Chicago:

Gentlemen—I transmit herewith a copy of Hon. J. H. Willard, Major, Corps of Engineers, U. S. A. preliminary report of the Chicago River, which I respectfully request be printed in our Proceedings,

Respectfully submitted,

(Signed) WILLIAM BOLDENWECK, President."

The following is the Preliminary Report:

"'Chicago, Ill., June 20, 1900.

Brig. Gen. John M. Wilson, Chief of Engineers, U. S.

Army, Washington, D. C.:

General—Complying with your wishes, indicated in your dispatch of this date, I have the honor to submit a preliminary report upon the current in Chicago River due to the flow of the Drainage Canal.

Since the Canal was opened under the provisional permit of the Secretary of War, only that member of the controlling works at Lockport known as the Bear Trap Dam has been operated, the stoney gates having been kept closed.

The Bear Trap, as you know, is a counter-poised hydraulic gate and can be set to remain at any elevation

between closed and wide open. During the observations for velocity and discharge the dam has been set at various heights to give estimated flow between 150,000 and 320,000 cubic feet per minute, and the observations have been taken at an interval after each setting that should give the full effect on the river. But inasmuch as the lake level is not constant and the reservoir capacity of the river between lake and Drainage Canal is large, it should not be expected that the mean velocity and discharge at any point in the river should be constant for a given setting of the Bear Trap Dam.

The subject cannot be covered by anything short of an elaborate investigation over a long period and through wide ranges of lake level, and therefore has not

been attempted.

The observations made to ascertain facts under existing conditions consisted in measuring discharges with current meter at critical points in Chicago River between lake and Canal, especially at bridges where the greatest dangers were to be feared, through as large a range as could be got with safety by successive settings of the Bear Trap Dam.

The discharges in the Canal were measured by meter and by rods for different settings to compare with Weir estimates and with measurements previously taken in the

Illinois and Desplaines Rivers.

The bridge sites giving the most restricted sections naturally were the places to expect the greatest velocities. They made the most convenient points for measurements. The observations have just been completed, as far as intended for the present, and the discharges are being computed.

Using preliminary computations for estimated volumes of discharge through the Canal, they are shown in two series with extreme velocities observed at each sta-

tion, in the following table:

MAXIMUM VELOCITIES IN CHICAGO RIVER IN FRET PER SECOND AND MILES PER HOUR FOR DISCHARGES IN CUBIC FEET PER MINUTE OF THE DRAINAGE CANAL.

	Discharge 150,000-210,000		Discharge	
Place of Observation.			270,000-310,000	
	F.S.	M.H.	F.S.	M.H.
Rush Street bridge	.1.88	1.28	2.36	1.61
Clark Street bridge		1.23	2.40	1.64
Wells Street bridge		1.03	2.40	1.64
Washington Street bridge	.2.12	1.46	3.21	2.19
Van Buren Street bridge		1.28	2.72	1.85
Eighteenth Street bridge	.1.67	1.14	2.77	1.88
Canal Street bridge		1.20	3.29	2.24
Halsted Street bridge		1.14	2.64	1.80
Average	.1.79	1.22	2.72	1.85

It is probably safe to estimate the mean velocities of the sections at about eighty per cent. of the maximum, giving an average of less than one mile per hour for discharge not exceeding two hundred and ten thousand cubic feet per minute and less than one and a half miles per hour for discharge not exceeding three hundred and ten thousand cubic feet per minute, and therefore the general current of Chicago River must be much less.

The greatest velocity corresponding to the greatest discharge of the Canal was observed at the Canal Street bridge, say two and a quarter miles per hour, and approximately one and three-quarters miles per hour for a mean velocity. This is one of the first bridges authorized to be replaced by a bascule, with large opening, under the general project of the Sanitary District for replacing bridges and widening Chicago River.

There is no doubt that the reversed current in Chicago River has increased the difficulty of navigating it with the large boats now demanded by commerce, but it is a noteworthy and gratifying fact, not unexpected by me at least, that the pilots have been quick to adapt themselves to the new conditions and I have little doubt but that they could handle their boats safely even in greater currents than now obtain.

If I have not overestimated pilots' skill, and considering the immense benefit of the Drainage Canal to the City of Chicago since its opening only a few months ago, I recommend that no restrictions be placed upon the

legal requirements of flow into the Sanitary Canal, unless it should be found absolutely necessary to do so.

The Engineer Department, the City of Chicago, and the Sanitary District are of one mind as to the need of improving Chicago River, and are co-operating heartily to that end, and large sums are appropriated and being expended judiciously by each for the objects in view. The interests of navigation are not only being protected, but are being advanced practically sooner than could be hoped for in the usual course.

Very respectfully, Your obedient servant,

(Signed)

J. H. WILLARD,

Major, Corps of Engineers.''

Proceedings San. Dist. of Chicago, 1900, pp. 6641-43.

EXTRACT FROM THE REPORT OF THE BOARD OF ENGINEERS ON DEEP WATERWAYS BETWEEN THE GREAT LAKES AND THE ATLANTIC TIDE WATERS. HOUSE OF REPRESENTATIVES DOC. 149 (56 CONG. 2D SESSION), BRING A REPORT BY LIEUT. COL. C. W. RAYMOND, ALFRED NOBLE AND GEO. Y. WISNER, 1900.

The board said:

"The board is of the opinion that the best location for works for regulating the level of Lake Erie is at the foot of the lake, just below Buffalo Harbor. The location in the Niagara River below Tonawanda has been advocated, but the board finds upon investigation that regulation by works at this point would be less effective and

much more expensive than at the adopted location.

The works projected by the board are designed to distribute the discharge of the lake so as to reduce its variation of level to a small amount. The result cannot be attained by the use of submerged fixed weirs only, and a series of sluices is added to secure, in combination with fixed weirs, the control desired. The weirs will be constructed of concrete blocks and will have an aggregate length of 2,900 feet. The sluices, 13 in number, of the Stoney type, will each have an opening of 80 feet,making an aggregate of 1,040 feet. The piers separating the sluice openings will be of substantial, first-class masonry. The sluices can be operated under rules easily formulated, and, in the opinion of the Board, amply provide for conditions more unfavorable than any recorded.

The location of these works and the details of their de-

sign are shown on plates 84, 85, 86 and 87. Their estimated cost is \$796,923.

Effect Upon Lake Erie.

The extreme high-water stage of Lake Erie is about 575 feet above tide water. The level adopted by the board for regulation is 574.5 feet, or about 0.5 feet below the level of extreme high water. This is the lowest elevation at which regulation can be effected without enlarging the cross section of the river at the gorge. Should it, for any reason, be considered desirable to regulate the lake at a lower level, the desired result can be accomplished by enlarging the cross section of the river so as to provide for the maximum discharge at the adopted level.

The board is of the opinion that with the works proposed the level of the lake can be maintained during the season of navigation within about 0.6 foot below the level adopted for regulation, under all conditions of supply heretofore recorded. Considerable changes of level due to violent winds would be temporary and infrequent, and, in the opinion of the board, would not seriously interfere with the regulation of the lake level.

Conclusion.

The board is of the opinion that works can be established for regulating the level of Lake Erie which will be of great value to navigation, not only in Lake Erie, but also in the upper lakes and connecting waterways, and will be of no injury to the lower waterways of the lake system, and that such works can be constructed at a cost which will be small compared with their benefit to commerce."

H. R. Doc. 149, 56 Cong. 2d Sess., pp. 48, 49.

EXTRACT FROM A REPORT MADE BY FRANCIS C. SHENEHON, PRIN. ASST. ENGINEER, TO CONGRESS IN REFERENCE TO THE PRESERVATION OF NIAGARA FALLS, MAY 30, 1908.

In conclusion Mr. Shenehan says:

"While this report has dealt with injurious effects on the Rapids and Falls of the Niagara River and with interferences with navigable ways in river and lake, and has shown these up in their limiting, hurtful amounts, it seems proper to suggest certain remedial measures that may serve to harmonize the preservation inviolate of the scenic grandeur with the useful application of the splendid power of the falls. Both of these things are eminent-

ly desirable and feasible.

A volume of 210,000 cubic feet per second with a descent between the 'dead line' and the Upper Gorge of 220 feet has a potential of over 5,000,000 horsepower. This is the power of 15,000,000 strong draft horses, each limited to an eight-hour day. If it takes 10 able-bodied men to do the work of one of these draft horses, the work potential in this fall is that of 150,000,000 men, nearly twice our population of men, women and children.

The great companies at the Falls have created in good faith power plants to lessen the hardships of human labor, to aid transportation, to illuminate the night hours, and to add to the wealth of two nations. The power houses for the most part are architecturally excellent, harmonizing with the scenic surroundings, and the mechanical wonders wrought in solving the engineering problems of the utilization of this great head and volume of water rival as a spectacle the scenic grandeur of the Falls and add to the attractiveness of the region.

It, therefore, appears proper to permit and foster such ultimate developments in addition to those already in force as are compatible with the perpetuation of the

scenic grandeur appreciable undiminished.

The water, however, and the power that is in it should be regarded as a national resource, and its use should

be under definite conditions and regulations.

No water should be used wastefully. Users of water should return in mechanical or electrical power all the energy that can reasonably be derived from it. The wasteful use of this national resource is illustrated by the expenditure of 1,332 cubic feet of water per second by the hydraulic company (see Chapter XIII) to secure 7,991 horsepower, or 6 horsepower to the cubic foot. As the water has a potential of 25 horsepower, or 19 horsepower on the shaft, more than two-thirds of the power is wasted. The balance of the water of this company is used economically.

The Niagara Falls Power Company (see Chapter XII) expends over a third of its potential power in getting the

water to and from its turbines.

The use of the water by the Canadian companies in

some cases shows corresponding waste.

The supervision of the economical use of the water should extend to all details of canals, sluices, forebays, penstocks, tailbays, tailraces and tunnels, and to all water wheels, generators, transformers, transmission lines and motors.

Supervision and regulation should extend to rates charged for power or light. The right to use a public resource implies the right of the people to an economic benefit.

The maintenance of scenically harmonious premises

and surroundings should be required.

Provided there be no large increase in up-lake diversions, the possibilities of continued and extended use of power at the falls are conditioned upon the construction of regulating works in the Niagara River to avoid the wasteful outflow of the water of Lake Erie. The injury to the scenic grandeur of the Falls, and the interference with the navigable waters of the Niagara River and Lake Erie, due to up-lake diversions, and the injury and interference coming from periods of drought would be largely obviated by appounding in the lakes a portion of the winter outflow. During the months of December to April, inclusive, enough water may be saved to hold the lakes to a proper and economical level to the betterment of navigation, and yield a surplusage to partially offset diversions at the falls. This is a practicable engineering proposition, but as the power companies are beneficiaries they should pay a fair share of the cost of the work.

The lessened winter flow over the Upper Rapids and falls would not scenically injure either, because ice and frost effects are an added attractiveness that cover up

unsightly shoals or unwatered crest lines.

A final consideration should be stated. The falls are operative only as a scenic spectacle during the daylight hours. When the night shuts in, partial depletion would

not be scenically injurious.

Should permits issue for half the flow of the river from sunset to sunrise, or for 12 or 16 hours every day, a tremendous power would become available that would furnish its own light, and factories might work by night instead of by day.

The temporary lowering of the river would immediately readjust itself when the sunrise shutdown came. The in-

terference with night navigation on the river would no be prohibitive in view of the benefits to be conferred i cheap power and light. The use of the night power a Niagara implies regulation of Lake Erie's outflow." Sen. Doc. 105, 62d Congress, 1st Sess., pages 75-76.

EXTRACT FROM A PAPER PREPARED BY MR. ALFRED NOBLE FO THE BOARD OF ENGINEERS ON DEEP WATERWAYS AND SUBMITTE AS APP. 4 TO THE REPORT OF SAID BOARD, PAGE 219.

"Principal Causes of Reduction of Speed of Ships i Restricted Waterways.

The speed attained by a ship in open sea will h reduced in a marked degree on entering shoal water, eve

if of unlimited width.

If the channel is restricted laterally as well as depth, the water moves back past the ship in the effort maintain a uniform level in the channel. The speed of the ship past a fixed point becomes less than its speed in rel tion to the water through which it moves.

3. The piling up of water in front of the ship and the lowering of water behind it set up a resistance to i motion. This takes place to some extent in open sea. Th discussion is concerned only with changes of condition when passing from open sea into a restricted channel.

The speed in a restricted channel must be limit to that which will not cause too great injury to the sie

slopes.

5. The speed must not be great enough to make t ship unmanageable. The speed in narrow channels must be reduced who

meeting other ships.

7. A lower rate of speed will be required in curv than on tangents by reason of the greater difficulty

steering the ship.

As already stated, some of these conditions can only discussed in a general way with results only approx mately correct; others can be evaluated wholly or in pa from the results of observation, as will appear in wh

Retardation in Shoal Water.—This depends (1) the form of the ship, so much so that the design of ship varied with regard to the depth of water in which it is navigate. Observations made recently on the free steamship Angeline in the deep water of Lake Huron at the shoal water of Lake St. Clair indicate that the retardation is about 18 per cent. The depth of water under the keel was about 2 feet 10 inches, no allowance being made for the settlement of a ship in the water, which always occurs when the water is shoal. The log of a recent trip of the steamship Senator, from Detour to Detroit, shows a speed of 12.2 miles in open lake and about 16 per cent. less in the shoal water of Lake St. Clair. The depth of water under the ship's keel, without allowance for settlement, was about 2 feet. These results are not so concordant as might have been expected, and the need of further observations is manifest. The estimated reduction of speed of the Angeline is derived by adding to an observed reduction of 11 per cent. in the speed of revolution of the wheel a further 7 per cent, for an estimated increase of slip. In the case of the Senator, the time was observed for the passage across Lake Huron, giving an accurate determination for speed in open lake and for the passage from the foot of St. Clair Flats Canal to Detroit. The latter includes 15 miles of shoal water, where the current is imperceptible, and 8 miles at the foot of Lake St. Clair and in Detroit River, where the water is 25 to 40 feet deep and the current about 1.8 miles per hour.

The log record would have been more satisfactory if the time had also been taken at the end of the 15 miles of shoal water in Lake St. Clair. The reduction of wheel speed of the Senator was about the same as for the Angeline, and it is, therefore, probable that the increase of slip of wheel of the latter ship was overestimated and the actual reduction of speed on entering shoal water was probably less than 18 per cent. For this discussion, however, it is deemed best to be on the safe side, and the reduction of speed is taken at 20 per cent. On this basis the speed of the ship will be reduced from 124 miles to 10 miles per hour on entering shoal water. It should be noted that the depth of the channel for the lake ship is assumed to be 2 feet more than the draft of the ship, while the depth of channel for the ocean ship is 3 feet more than its draft. Obviously, the excess for the deeper draft ship should be the greater, but the additional 1 foot is doubtless more than needed to equalize the conditions.

In designing the 21-foot waterway it was found that in the lower portion of the Mohawk Valley, where a slack water navigation is intended, a deep channel will be cheaper than a shallow one. This led to the adoption of a 30-foot channel in this section for both the 21-foot and 30-foot navigation. The reduction of speed sustained by a ship drawing 19 feet will be much less in water 30 feet deep than in water 21 feet deep. While there are no available data to determine what the difference will be, it appears safe to assume that the reduction of speed of a ship drawing 19 feet will not be more than 10 per cent. when passing from deep lake into 30 feet of water of unlimited width. If the speed is 12½ miles per hour in deep, open water, its speed in water 30 feet deep will be, on this basis, 11½ miles per hour.

These reductions of speed for the several channels and type ships appear in column 5 of Tables III, IV and V."

H. R. Doc. 159, 56 Cong., 2d Sess., pages 219-220-221.

EXTRACT FROM MECHANICAL ENGINEERS' POCKET BOOK BY WILLIAM KENT, SECOND EDITION, 1896, PAGE 1008.

"Results of Progressive Speed Trials in Typical Vessels. (Eng'g, April 15, 1892, p. 463.)

		Atlantic
The Street Street Street	'Medusa'	Passenger
	-Cl. Cruiser.	Steamer.
Length in feet		525
Breadth in feet	41	63
Draught (mean) on trial	16' 6"	21' 3"
Displacement (tons)	2,800	11,550
I. H. P.—10 knots	700	2,000
I. H. P.—14 knots	2,100	4,600
I. H. P.—18 knots	6,400	10,000
I. H. P.—20 knots		14,500
1. II. I 20 Anoto		

The figures for I. H. P. are 'round'; the 'Medusa's' figures for 20 knots are from trial on Stokes Bay, and show the retarding effect of shallow water. The figures for the other ships for 20 knots are estimated for deep water."

EXTRACT FROM REPORT BY COL. W. M. BLACK, C. E. UNITED STATES ARMY, FEBRUARY 27, 1912, THE SAME BEING A PRE-LIMINARY EXAMINATION OF THE HUDSON RIVER, NEW YORK, WITH A VIEW TO SECURING INCREASED DRPTH AS REQUIRED BY THE RIVER AND HARBOR ACT OF JUNE 25, 1910.

"83. Minimum Clearance for Safety.—Navigation is possible wherever the depth of channel exceeds the draft of the vessel in motion. As affected by the depth, naviga-

tion is safe only where the channel is at all times free from obstructions rising above the general level of its bottom or where the depth is such that there is sufficient clearance between the bottom of the moving vessel and the channel bottom to enable her to pass over any obstruction whose presence is not definitely known and which, therefore, cannot be avoided. The nonexistence of obstructions can be assured only in channels which are continually watched. and is practically attainable only in very restricted water ways such as the entrances to important locks; while sufficient clearance to avoid all possible obstructions can seldom be secured in artificial channels except at prohibitive cost. Hence, a compromise must be made, based on the character of obstructions likely to be encountered, and the nature and volume of the commerce. Under the conditions obtaining in the Hudson River it is thought that reasonable safety required that the clearance be such that obstructions whose presence is known to be probable will be Such obstructions are building stone or passed over. barrels of cement dropped from the decks of barges, snags brought down by the freshets, pieces of wreckage, lost anchors, etc., and the condition of the bottoms of most of the steamers and bills for repairs on the books of the navigation companies bear evidence of the frequency of their occurrence. Great stress is laid on this phase of the question by the officials of the Hudson River Day Line. Where freight-carrying vessels are forced for other reasons to run at very slow speed in a carefully watched channel such as that of a canal, the risk involved in operating with little or no clearance may not be sufficient to justify the expense of obtaining a deeper channel. In the Hudson River effective precautions cannot be taken against the creation of small obstructions, while the river is navigated by both freight carriers and large passenger steamers, making the danger from hitting small obstructions too great and the results too disastrous to justify operation with an adequate clearance. While the existence of obstructions is at present evidenced chiefly by the guarded slow running in the shoal reaches of the river, the liability of serious disasters from this cause is always present, and must increase in a geometrical ratio with the increase in traffic, there being more vessels to create obstructions and more to hit them. Considering the character of most of the obstructions encounterd and the volume and character of traffic anticipated, it is believed that the minimum clearance allowable for safe navigation in the Hudson River is 2 feet. In Germany the clearance adopted as safe

is 1 meter (39 inches).

Relations Between Factors in Channel Design.-It is a matter of common knowledge that a vessel in motion apparently draws more water than when at rest; that this increase in draft is greater in shoal water than in deep water, and that for a given speed, more power is required in shoal water than in deep water. increase in draft referred to is commonly known 'squat.' While the among boatmen as of these phenomena is well known, there is either an absence of knowledge or a great diversity of opinion with regard to the exact relations obtaining between them. These relations are of vital importance in the determination of proper channel depth, since they affect directly the clearance, power consumption, cost of channel maintenance, and speed; and for this reason it has been attempted to demonstrate, at least approximately, the relations existing between draft, speed, power, and channel cross section under the local conditions prevailing on the upper Hudson. A study has been made of past researches along this line and observations were taken on vessels in actual operation.

85. Details of the information obtained and of the results of the observations made are given in inclosure G of this report. The most important deductions are as follows:

(a) The squat of a given boat underway is a function of the channel depth and of the speed of the boat. For channels varying in depth from 12 to 16 feet the squat decreases as the depth increases.

The curves deduced show the following relations (pl. 5

of inclosure G):

Channel Depths. 12 to 13 13 to 14 14 to 15 15 to 16 (Feet.) (Feet.) (Feet.) (Feet.)

 Speed 8 miles per hour, squat
 1.4
 1.2
 1
 0.9

 Speed 10 miles per hour, squat
 2.25
 1.9
 1.5
 1.4

In the observed case of the paddle wheel steamer Hendrick Hudson, 400 feet long, 45 feet beam of hull, and with normal draft of 9½ to 10 feet, when moving in water 135 feet deep at a speed of 22.5 miles per hour, the squat was 0.99 foot. In the same depth at 11.5 miles per hour

the squat was 0.15 foot. In water 14.4 feet deep at a speed of 9.14 miles per hour the squat was 1 foot. In water of practically the same depth the greatest speed she could make was 9.48 miles per hour, and the squat was 3.25 feet.

(b) As might be deduced from the above, the squat at any depth is a function of the power consumed. For a given boat in a given depth of from 12 to 16 feet the squat increases rapidly under the exertion of from 0 to 250 horsepower and more slowly after that power is reached. Here, again, the squat is shown greatest for the least

depth. (See inclosure G.)

(c) The relation of power to speed in varying depths for a given boat of 7 feet 6 inches draft is shown by the curves of plate 2 of inclosure G, the relative increase of power required being the greater in the lesser depths. For example, to attain a speed of 8 miles per hour in depths varying from 12 to 20 feet the power required will vary from 250 to 125 horsepower. To attain a speed of 10 miles per hour the power runs from 700 to 300 horsepower. In other words, for the given boat moving in 12 feet of water the expenditure of 225 horsepower will give her a speed of 8 miles per hour; while to attain a speed of 10 miles per hour 700 horsepower must be exerted. In 20 feet of water the same boat would have a speed of 9.4 miles per hour with the expenditure of 225 horsepower, and of 12.4 miles per hour for 700 horsepower.

In the case of the *Hendrick Hudson*, previously cited, in about 14 feet of water she exerted 350 horsepower in attaining the speed of 9.1 miles per hour and 730 horse-

power for a speed of 9.48 miles per hour.

(d) For a given boat the swells produced were a function of the depth and speed, and the destructive effect a function of the channel width.

In 135 feet of water, at a speed of 22.5 miles, the swell produced by the *Hendrick Hudson* was about 1 foot and

was inappreciable at a distance of 1,000 feet.

At Bogart Island, near Albany, in a width of 770 feet and a channel depth of 12 feet, while running at a rate of 11 miles per hour, the swell raised at the shore was 5.5 feet from hollow to crest.

86. Specific Deductions .- A study of the curves and of

inclosure G will lead to the following conclusions for vessels of the class found in the Hudson River:

1. That in 12 feet of water safe clearance cannot be maintained.

2. That in 13 feet of water safe clearance can be maintained with a speed less than 8 miles per hour.

3. That in 14 feet safe clearance can be maintained with a speed of 10½ miles per hour, but that at this speed the power consumption will be uneconomical and the swells damaging.

4. That in 16 feet a speed of 12 miles per hour can be

maintained safely and economically.

That speeds greater than 14 miles per hour are uneconomical or unattainable except in very deep water.

The large steamers of the Day Line are designed to operate economically at a speed of 20 miles per hour in deep water. They are scheduled to make the run from New York to Albany as a daylight trip in about 10 hours, and the volume of their through business depends largely on the time element. At present the average speed of both day and night boats north of Hudson is from 7 to 12 miles per hour. The night boats are designed for an economical speed of 15 miles per hour. As they make no stops between Albany and New York, the question of speed is not so important to them as to the Day Line. The most important benefits to be gained by an increase in depth would be for the day boats greater speed and for both day and night boats economy in power and safe clearance."

House of Representatives, 62d Congress, 3d Sess. Doc. No. 1160, pages 34-35-36.

EXTRACT FROM REPORT OF LIEUTENANT R. D. BLACK, INCLOSURE G. OF THE REPORT OF COL. W. M. BLACK ON THE EXAMINATION OF THE HUDSON RIVER, NEW YORK, H. R. DOC. NO. 1160, 62D CONGRESS, 3D SESSION, PAGES 100 AND 102.

"(b) From a set of observations made by the United States under the supervision of H. N. Babcock, United States assistant engineer, on screw steamers operating in a relatively deep channel near Sandy Hook, N. Y., the data contained in the following table were obtained:

Draft of vessel	Draft	Depth of Squat	Velocity	Clearance
at pier.	in	water in	of vessel	

at pier.		in	water in		of vessel		
Bow	Stern,	channel	channel.		in miles		
24.6	25.8	29.2	31.7	3.4	18.0	5.9	
24.0	26.0	29.0	32.3	3.0	15.2	6.3	
29.1	29.5	32.1	35.8	2.6	17.9	6.3	
24.3	25.2	26.7	33.3	1.5	15.2	8.1	
22.2	24.7	25.8	37.7	1.1	14.5	13.0	
HR	Doc No	1160 69	d Congre	ss 3rd	Session	nage	100

H. R. Doc. No. 1160, 62d Congress, 3rd Session, page 100.

"8. These relations were deduced for and apply exactly to one class and size of steamer only. By using Froude's Laws of Comparison, a similar set of relations may be obtained for other types. However, for use in determining channel requirements in the Upper Hudson, it is thought proper to assume that the relations as given above apply to a vessel not over 500 feet long, with beam over guards of 90 feet, beam of hull 60 feet, and a load draft at rest of 10 feet as the standard steamer to be accommodated. Under these assumptions the following deductions can be made:

(1) That in 12 feet of water safe clearance cannot be maintained.

(2) That in 13 feet of water safe clearance can be maintained with a speed less than 8 miles per hour.

(3) That in 14 feet safe clearance can be maintained with a speed of 10½ miles per hour, but that at this speed the power consumption will be uneconomical and the swells damaging.

(4) That in 16 feet a speed of 12 miles per hour can

be maintained safely and economically.

(5) That speeds greater than 14 miles per hour are uneconomical or unattainable except in very deep water.

The large steamers of the Day Line are designed to operate economically at a speed of 20 miles per hour in deep water. They are scheduled to make the run from New York to Albany as a daylight trip in about 10 hours, and the volume of their through business depends largely on the time element. At present the average speed of both day and night boats north of Hudson is from 7 to 12 miles per hour. The night boats are designed for an economical speed of 15 miles per hour. As they make no stops between Albany and New York, the question of

speed is not so important to them as to the Day Line. The most important benefits to be gained by an increase in depth would be, for the day boats, greater speed, and for both day and night boats economy in power and safe clearance."

H. R. Doc. No. 1160, 62d Congress, 3d Session, pages 102-103.

EXTRACT FROM A SPECIAL REPORT BY LT. COL. W. H. BIXBY, U. S. ENGINEER, AT CHICAGO, ENTITLED "EFFECT OF WITH-DRAWAL OF WATER FROM LAKE MICHIGAN BY THE SANITARY DISTRICT OF CHICAGO," DATED MAY 22, 1906.

(H. R. Doc. 6, 59th Cong., 1st Sess.)

Page 6:

Furthermore, by reason of winds and barometric effects, oscillations of 6 inches several times in a single day are frequent, and 2 to 4 feet within an hour are occasionally experienced. Consequently, individual exceptional levels are misleading, and the general effects of water diversions must be measured by annual average rather than by monthly or daily.

The only way of avoiding such extra dredging will be by holding up the water levels of all these lakes by dams and other controlling works across the exits of these lakes, which will be expensive and probably impracticable for Lakes Michigan and Huron and expensive, but practicable and eventually probable, for Lake Erie. The diversion of the 14,000 cubic feet per second named in the request of the Chicago sanitary district of April 11 would therefore mean future dredging some day to 0.7 foot extra depth in all harbors of Lakes Michigan and Huron and to 0.6 foot in those of Lake Erie (or its equivalent in dams, etc.). The cost of such dredging or of dams, etc., will be the price to be eventually paid by the Federal Government for granting such privileges to the sanitary district.

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In the few cases where past troubles from currents have been real, they have been due to the contracted channel ways at bridges, tunnels, and other special points, where full dimensions of water flow have already been secured or are being secured by the drainage district improvements, or will be soon provided by tunnel owners. These troubles in the past have been quite freely and fully commented upon or reported upon by the boat interests and by this office, the most important of such reports being those of the hearing before the honorable Secretary of War, May 16, 1900 (E. D. 35242/7), that of Major Willard, February 16, 1901 (with third indorsement on E. D. 35242/26), that of Major Willard, June 20, 1900 (E. D. 35242/(?)), that of Major Willard, March 29, 1901 (with third indorsement on E. D. 35242/40), and that of Colonel Ernst, November 5, 1901 (which led to permit E. D. 35242/74, quoted above). These reports show that the greatest velocity heretofore actually observed at any single point of the worst old bridge draw opening (that of Canal street, now greatly improved), was 2.24 miles per hour (3.29 feet per second), while the average for a whole cross section at this draw was only about 1.8 miles per hour (2.6 feet per second), and the average for a full 200-foot width of river just above and below the bridge would not have been over 1.2 miles per hour (1.8 feet per second); and that even a large part of this was probably due to sudden changes of lake levels for which the drainage district was not responsible. These currents, although much complained of at the time, are not greater than are constantly encountered in many tidal rivers on the Atlantic coast, where no complaints are made, because all boat captains and pilots are accustomed to such currents and make their arrangements accordingly.

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17. In the capacity of sewer to properly carry off all the diluted sewage which the sanitary district must dispose of in the future, the South Branch and West Fork of Chicago River and the district drainage canal will need the use of the full cross section now being given to them at their typical points of constriction, viz., 4,700 square feet in South Branch, Chicago River, where a future 8,000 cubic feet per second is now asked for; 5,200 square feet in West Fork, South Branch, Chicago River, 5,412 square feet in the earth sections and 3,542 square feet in the rock sections of the drainage canal, for all of which 10,000 cubic feet per second is now asked for; and 5,412 square feet in the lower (south) end of the drainage canal, where 14,000 cubic feet per second is now being asked for. I assume that after this volume of water

reaches the Des Plaines and Illinois rivers it can be taken care of more easily than in the Chicago River and that the 2.800 square feet cross section of the proposed 14-foot waterway, now under consideration by Congress, will be supplemented sufficiently by the rest of the natural river on each side of the improved boat channel. The above cross-sections, so long as no boats lie at wharves or pass up and down the river, will allow the passage of the 8,000 cubic feet per second through the South Branch, with average velocities of not exceeding about 1.2 miles per hour (1.7 linear feet per second): 10,000 cubic feet through the West Fork, with average velocities of not exceeding about 1.3 miles per hour (1.9 linear feet per second), and the same flow through the earth sections of canal at not exceeding 1.2 miles per hour (1.8 linear feet per second), and through the rock section of canal at not exceeding 1.9 miles per hour (2.8 linear feet per second); and 14,000 cubic feet through the lower end of canal at not exceeding 1.8 miles per hour (2.6 linear feet per second).

Wherever the full free cross section of the river is obstructed by bridge abutments or by boats, either at docks or passing, the average 8,000 to 10,000 cubic feet per second water flow must pass through the reduced cross section at increased speed. The full development of this increase, while not instantaneous, will require only a few moments. In this manner, at bridges, the velocities will be increased for a short length by about 30 per cent.; at places where two boats of 40 to 50 feet beam and 800 square feet wetted cross section are abreast the increase of velocity will be about 50 per cent.; at places where three such boats are abreast the increase will be about 100 per cent.; and in case four such boats should be abreast (one tied up at the wharf on each side of the stream and two others trying to pass in midriver), the increase will be about 200 per cent. The drainage currents in the South Fork, South Branch, due to the 2,000 cubic feet per second coming from the Thirty-ninth street pumping station, and in the North Branch, due to a similar pumpage probably soon to be established at some street near Evanston, in the north end of Chicago, will be only about one-half of those in the South Branch, and their effects will probably be so small as not to be complained of by navigation interests. The drainage currents in the canal proper between the West Fork and Lockport will be about the same as in the South Branch; but as this part of the canal was not originally a public water way and has not yet been accepted as such by the Federal Government, it is doubtful whether the United States can object to any currents which its owners may establish or desire to establish therein. It is therefore evident that so long as the Chicago River serves merely as a sewer and is not to be used by boats the drainage district currents will not be objectionable, but as soon as it is also used as a harbor or as a canal or water route the currents begin to be seriously questionable.

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25. Summing up the above it may be briefly stated, therefore, that 10,000 cubic feet per second dversion of water from Lake Micihgan into the drainage canal will be, probably, not unreasonably obstructive to navigation and injurious to property if divided up into 6,000 cubic feet per second through the main river and south branch, increased by 2,000 cubic feet per second more through the Thirty-ninth street sewer and 2,000 cubic feet per second more through Calumet River (10,000 cubic feet per second in all), but that an increase in these amounts to 8,000, 2,000, and 4,000 cubic feet, respectively (14,000 cubic feet per second in all), will probably prove to be unreasonably obstructive and injurious. Also that the 10.000 cubic feet per second will eventually and permanently lower the levels of Lakes Michigan and Huron by about 0.5 foot and Lake Erie by about 0.4 foot, and 14,000 cubic feet per second will make these depths 0.7 and 0.6 foot, respectively, which will be quite costly in future results.

EXTRACT FROM THE REPORT ON A WATERWAY FROM LOCKPORT. ILL, TO THE MOUTH OF THE ILLINOIS RIVER, BY A SPECIAL BOARD OF ENGINEERS OF WHICH GEN. W. H. BIXBY WAS CHAIRMAN, DATED JAN, 23, 1911.

(H. R. Doc. 1374, 61st Congress, 3rd Session.)

By virtue of the act of Congress of March 30, 1822, dedicating to the State of Illinois the land necessary for a canal connecting the Illinois River with Lake Michigan, and the act of March 2, 1827, granting to the State certain public lands for the purpose of aiding in its construction, and the acceptance by the State of the conditions imposed therein, the State of Illinois obligated itself to construct a suitable

waterway from Lake Michigan to the navigable waters of the Illinois River. In accordance with this agreement the State constructed the Illinois and Michigan Canal, from Bridgeport to LaSalle, and improved the upper portion of the Illinois River by the construction of locks and dams at Henry

and Copperas Creek.

For many years this waterway was a valuable transportation route, but in recent years the State has neglected it and failed to maintain it abreast of the needs of commerce. The work now proposed by the State in connection with the canal of the Chicago Sanitary District contemplates a waterway from Lake Michigan to Utica, which, although departing from the line of the old canal, substitutes a waterway more than sufficient for any probable navigation. This will in effect fulfill the original agreement between the State and General Government for this section and incidentally develop a water power which the State considers a profitable business investment. State or local agencies are better adapted than the General Government for conserving water power for their citizens.

The Board believes that the State is more generous in its provisions for navigation than necessity requires, that the locks it proposes are larger than will be utilized, and that its original agreement would be amply fulfilled if it constructed locks 600 by 80 by 11 feet, and reserved at each lock ground sufficient for an additional lock should it ever be required, but it is also of the opinion that the State should be permitted to expend its own funds in such manner as it With locks of the dimensions suggested by deems proper. the Board the \$20,000,000 authorized to be appropriated by the State should complete this part of the waterway; and unless large expenditures are required for power rights, even

the larger locks could be constructed for that amount.

The General Government will then fully co-operate with the State in a waterway from Lockport to the mouth of the Illinois River if it assumes charge of the State structures at Heary and Copperas Creek, and enlarges the existing channel in the Illinois River below Utica to suitable dimensions. The Mississippi river from the mouth of the Illinois to St. Louis should also be suitably deepened.

ORDINANCES OF THE CITY OF CHICAGO, IN CHICAGO CODE, 1911.
ABTICLE V, SECTIONS 1130, 1131, AND 1134, PP. 429-430.

Article V.

SANITARY REGULATIONS OF HARBOR.

1130. Befouling Stream-Dredging-Penalty | No person shall cast or deposit or suffer to be cast or deposited in the harbor of the city or anywhere in Lake Michigan within five miles of the harbor, any earth, ashes or other heavy substance or substances, filth, logs, or floating matter, or any No tug owner or captain or other person in obstructions. charge or command of a tug shall tow, inside the harbor, any dumping scow or like vessel, with or without a collapsible or adjustable bottom, loaded with clay, earth, ashes, filth or other substance or substances unless there is on board at the time of such towing an inspector from the department of public works. It shall be unlawful for any dredge or other machine to cut clay or dredge sand or other material from the bed or bottom of the harbor of the city, unless the person present conducting such work have in his possession a permit in writing from the department of public works, in which permit the location and time occupied in such work shall be specified, and such person conducting such work shall produce such permit on demand of the harbor master or any of his assistants. It shall be the duty of the harbor master to cause the arrest of any person in charge of any tug, scow or dredge who violates any of the provisions of this section, and such person shall be fined not less than fifty dollars nor more than one hundred dollars for every such offense.

1131. Garbage in Lake, or River—Penalty No person shall throw, place or deposit or cause to be thrown, placed or deposited any garbage, vegetable matter, dung, carrion, dead animal, offal or putrid or unwholesome substance, or the contents of any privy, upon the margin or banks or into the waters of the harbor.

Any person who violates, or fails to comply with, any of the provisions of this section shall be fined not less than ten dollars nor more than two hundred dollars for each offense.

1134. Contents of Privy, Etc., in Lake or River.—Penalty] No person shall throw, drop or permit to fall into the harbor, any offal or any unwholesome substance being or having been part of the contents of any vault, cesspool, catch basin, privy, sink, tub or receptacle.

Any person who violates or fails to comply with any pro-

vision of this section shall be fined not less than ten dollars nor more than two hundred dollars for each offense.

EXTRACT FROM INTERNATIONAL WATERWAYS COMMISSION PROGRESS REPORT, TRANSMITTED TO CONGRESS BY PRESIDENT TAFT DECEMBER 3D, 1912, SENATE DOC. No. 959, 62D CONGRESS, 31 SESSION, PAGE 8.

(Extract from the report of the American Commissioners Col. Ernst, George Clinton and E. E. Haskell):

"Niagara River.

9. Upon taking up the subject of the Niagara River the commission found that great amounts of capital had been, and were continuing to be, invested in power works at Niagara Falls by private corporations under the au thority of the State of New York or of the Province of Ontario. Many millions of dollars had been expended in the works themselves and many millions more in the in dustrial enterprises to which they furnished power. I addition to the five principal corporations actually en gaged in the development of water power, there were several other corporations preparing to engage in tha work under franchises, some of which had been grante and others of which were being sought for. The total de struction of Niagara Falls, as a scenic spectacle wa It seemed desirable that this movemen should be checked without delay, and as the collection o all the data and the preparation of a full report would require time, the commission at its meeting of October 28 1905, passed the following resolution, of which copie were sent to the Secretary of War of the United State and the minister of public works of Canada, viz.:

Resolved, That this commission recommends to the governments of the United States and Canada the such steps as they may regard as necessary be take to prevent any corporate rights or franchises being granted or renewed by either Federal, State or Previnicial authority for the use of the waters of the Niagara River for power or other purposes until the commission is able to collect the information necessary to enable it to report fully upon the 'condition and uses' of those waters to the respective governments of the United States and Canada.

10. By March, 1906, the information necessary for report had been collected, public hearing, had been hele and an original map of the locality, specially constructe for the purpose, had been prepared, when Congress passes

the following joint resolution, approved March 15, 1905, viz.:

Resolved, By the Senate and House of Representatives of the United States of America in Congress assembled. That the members representing the United States upon the international commission created by section four of the river and harbor act of June thirteenth, nineteen hundred and two, be requested to report to Congress at an early day what action is, in their judgment, necessary and desirable to prevent the further depletion of water flowing over Niagara Falls; and the said members are also requested and directed to exert, in conjunction with the members of said commission representing the Dominion of Canada, if practicable, all possible efforts for the preservation of the said Niagara Falls in their natural condition.

The American section accordingly submitted a report, dated March 19, 1906. It was published as Senate Document No. 242, Fifty-ninth Congress, first session. It was subsequently concurred in substantially by the Canadian section, and the joint report of the full commission, dated May 3, 1906, was published as Senate Document No. 434,

Fifty-ninth Congress, first session.

The report of March 19 was followed by an exhaustive investigation of the subject by the Rivers and Harbors Committee of the House of Representatives, who, during several weeks, held public hearings in Washington, at which all persons interested were given an opportunity to be heard, and who sent a subcommittee to Niagara Falls, where a thorough inspection of the works was made, and where also there was a public hearing. result was a confirmation of the report in all essential particulars.

12. An 'act for the control and regulation of the waters of Niagara River, for the preservation of Niagara Falls, and for other purposes,' approved June 29, 1906, was then passed by Congress. It authorized the Secretary of War to grant permits for the diversion of water on the American side, and for the transmission of electrical power from Canada, under certain prescribed conditions and to certain prescribed limits. The total amount authorized being considerably less than the amounts applied for by the power companies, a more detailed investigation, which should embrace particularly the commercial and financial side of the power-producing industry at Niagara Falls, became necessary to insure an equitable division of the amounts authorized. Capt. Charles W. Kutz, Corps of Engineers, United States Army, was detailed by the Secretary of War to make the investigation, his reports to be submitted to the American section for review and recommendation. Under these instructions the American section submitted two reports, dated September 29. 1906 (Appendix A), and November 15, 1906 (Appendix B) respectively. Special difficulties having ar sen in granting a permit for the diversion of water from the Erie Canal, the American section, under instructions from the Secretary of War, caused a map of Lockport, N. Y., to be prepared, and new measurements of flow to be made at that place, and under date of March 5, 1907, submitted a special report with a form of permit. (Appendix C.)

13. Other reports relating to power development in the Niagara River were dated September 9, 1907, and March 3, 1908. The first was by the American section, and related to a letter from the Niagara Falls Hydraulic Power & Manufacturing Company to the Secretary of State, in connection with the treaty then under negotiation with Great Britain. (Appendix D.) The second was by the full commission, and related to a bill to authorize the diversion of water below the Falls, which had been referred to the commission by the Rivers and Harbors Committee of the House of Representatives of the United

States. (Appendix E.)

During the summer of 1908 the works of the Niagara Falls Power Company were shut down on three occasions, and upon one of these occasions the works of the other power company on the American side, the Niagara Falls Hydraulic Power & Manufacturing Company, also were almost completely shut down. The commission, having been notified in advance, took advantage of the opportunity to observe the effect upon the river and the Falls of the diversion or nondiversion of the considerable body of water used by those companies. By its direction its American secretary installed water gauges at various points at and above the falls and had them observed before, during and after the shutdowns, and afterwards discussed his observations in a report. The conclusions which he reached were that the diversion of 8,000 cubic feet per second through these plants lower the level of Niagara River at Grass Island, near the intake of the Niagara Falls Power Company, about 31 inches; near the Ontario intake, on the Canadian side, about 11 inches, and at Prospect Point, the crest of the American Falls, about four-tenths of an inch. The observations are a valuable contribution to existing knowledge of the effect of power diversion upon the falls."

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"CHICAGO DRAINAGE CANAL.

21. On the 4th of January, 1907, the full commission submitted to the two governments a report upon the Chicago Drainage Canal, which closed with the following summary and recommendations:

SUMMARY.

(a) Chicago obtains its water supply from Lake Michigan, and to avoid polluting it must either dispose of its sewage otherwise than in the lake or place its intakes for water at a great distance from the city.

(b) The topography of the country favors the discharge of the sewage into the Des Plaines River, a tributary of the Mississippi, through two depressions in the divide which separates the river from Lake Michigan.

(c) The slope on the lake side of the divide is drained by two streams, the Chicago River and the Calumet River, into which the sewers of the city empty. By a cut through the northerly depression the flow of the Chicago River has been reversed and diverted into the Des Plaines River instead of into Lake Michigan, and by a cut through the southerly depression the same process can be applied to the Calumet River.

(d) To make this reversal effective the channels must be large enough to take all the water which falls upon the respective drainage areas during the most violent rain storms. This amount is estimated at 10,000 cubic feet per second for the Chicago River and 15,700 cubic feet per

second for the Calumet River.

(e) The City of Chicago was originally built upon the Chicago River, and that stream now drains the richest and most populous part of the city. It is now spreading

over the Calumet region.

(f) In 1889 the plan of diverting the Chicago River into the valley of the Des Plaines was definitely adopted and the Chicago Drainage Canal was undertaken. It was designed to carry 10,000 cubic feet per second. Though

not entirely completed, it has been in use since January, 1900. The amount expended upon the canal and acces-

sory work is about \$41,000,000.

(g) The Illinois law which authorized the canal required a flow of 333 cubic feet per second for each 100,000 of population in order to render the sewage inoffensive. This amount of dilution is probably not excessive. It is reasonable to expect a population in a future not remote of five or six million or more, involving the diversion by this standard of some 20,000 cubic feet per second. The Chicago River, with its 10,000 cubic feet, provides for a population of 3,000,000. The present population of the city is about 2,000,000.

(h) It is now proposed to apply to the Calumet River a treatment similar to that applied to the Chicago River—viz., to reverse its flow, so that instead of discharging into Lake Michigan it shall discharge into the Des Plaines, but for a part of the new route it must follow the drainage

canal already excavated for the Chicago River.

(i) Although the Chicago Drainage Canal was designed to carry 10,000 cubic feet per second, it is found to have, in its completed rock portion, an actual capacity of 14,000 cubic feet. This additional capacity fixes the amount which it is proposed to divert from the Calumet at 4,000 cubic feet per second. Any greater amount from the Calumet will overtax the drainage canal at the expense of the richest part of Chicago and for the benefit of a suburban part.

(k) The diversion of only 4,000 cubic feet will not be effective at all times, since a much larger amount must be diverted from the Calumet during heavy rainstorms if the lake is to be protected. Moreover, it provides for a population not exceeding 1,200,000, which number will probably be exceeded at a date not far dis-

tant.

(1) The large channels necessary to provide for the contingencies of rainstorms are capable of discharging a volume of water largely in excess of sanitary requirements during the greater part of the year, but the development of water power creates the demand that they be employed to their full capacity throughout the year.

(m) The diversion of large bodies of water from Lake Michigan for supplying the drainage canal has not been authorized by Congress, but there appears to be a tacit general agreement that no objection will be made to the diversion of 10,000 cubic feet per second, as orig-

inally planned.

(n) The diversion of 10,000 cubic feet per second, will lower the levels of Lake Michigan-Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence River, besides the important connecting channels, the Detroit and St. Clair Rivers, by amounts varying from 4½ to 6½ inches for the different waters, and the diversion of 14,000 cubic feet will lower them from 6 to 8½ inches. The diversion of 20,000 cubic feet will lower Lake Michigan-Huron about 13 inches and Lake Erie about 11 inches.

(o) The lake traffic which passed through the Detroit River in 1905 was about 58,000,000 tons, valued at about \$615,000,000. It is increasing annually with marvelous rapidity. The records for the year 1906, so far as they are made up, indicate that the number of tons which passed through the Detroit River in 1906 exceeded 65,000,000, valued at \$690,000,000. The lowering of the water surface has a very injurious effect upon this traffic and upon that of the Welland and St. Lawrence Canals. Chicago being one of the principal lake ports, there will be very few communities which will feel the

injury more than she will.

(p) The cost of restoring the depth in the harbors of the Great Lakes and the channels between the lakes is estimated at \$10,000,000 and of restoring it in the Welland and St. Lawrence Canals at \$2,500,000. This expenditure would not prevent very serious annoyance to the navigation interests during the execution of the remedial works, which would occupy several years. In Lake St. Clair, navigation of the open lake would be replaced by that of an artificial channel or canal with submerged banks.

(q) The extension to the Calumet' region of the method of sewage disposal already applied to the Chicago River is not necessary to preserve the health of Chicago, there being other and better methods available for the Calumet region. The final cost of these methods is somewhat greater than that of the one proposed, but the works can be developed as the population increases, and only a part of their cost need be incurred at present, while their greater efficiency justifies the increase of final cost.

(r) The diversion of 10,000 cubic feet of water per second at Chicago will render practicable a waterway to the Mississippi River 14 feet deep. Any greater depth must be obtained by the abstraction of more water from Lake Michigan and at the expense of the navigation interests of the Great Lakes and of the St. Lawrence Valley.

(s) The effect upon Niagara Falls of diverting water at Chicago is of secondary importance when considering the health of a great city and the navigation interests of the Great Lakes and of the St. Lawrence Valley, but it is proper to note that the volume of the Falls will be di-

minished by the full amount diverted at Chicago.

RECOMMENDATIONS.

The waters of Lake Michigan in the United States. the waters of Georgian Bay in Canada, and the waters of Lake Superior, partly in the United States and partly in Canada, all form sources of supply of the Great Lakes system, finding their way by the St. Lawrence to the sea. All are interdependent, and there can be no diversion from any of them without injury to the whole system. By Article XXVI of the treaty of 1871, it is provided that 'navigation of the River St. Lawrence, and descending from the forty-fifth ascending of north latitude, where it ceases parallel form the boundary between the two countries, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain, or of the Dominion of Canada, not inconsistent with such privileges of free navigation.' It is desirable that in any treaty arrangement the water of Lake Michigan, Georgian Bay, and all other waters forming part of the Great Lakes system should be declared to be 'forever free and open for the purposes of commerce' to the citizens of the United States and the subjects of His Britannic Majesty, subject to any laws or regulations of either country not inconsistent with such privilege of free navigation.

(u) The preservation of the levels of the Great Lakes is imperative. The interest of navigation in these waters

is paramount, subject only to the right of use for domestic purposes, in which term is included necessary sanitary purposes. In our report of November 15, 1906, upon the application of the Minnesota Canal and Power Company to divert certain waters in Minnesota, we recommended among other things:

'That any treaty which may be entered into should define the uses to which international waters may be put by either country without the necessity of adjustment in each instance, and would respectfully suggest that such

uses should be declared to be-

'Uses for necessary domestic and sanitary purposes.

'Service of locks for navigation purposes.

'The right to navigate.'

It is our opinion that so far as international action is concerned a treaty provision of that kind is all that is required in this case. We accordingly renew our recom-

mendation of November 15, 1906, just quoted.

(v) A careful consideration of all the circumstances leads us to the conclusion that the diversion of 10,000 cubic feet per second through the Chicago River will, with proper treatment of the sewage from areas now sparsely occupied provide for all the population which will ever be tributary to that river, and that the amount named will therefore suffice for the sanitary purposes of the city for all time. Incidentally, it will provide for the largest navigable waterway from Lake Michigan to the Mississippi River which has been considered by Congress.

We therefore recommend that the Government of the United States prohibit the diversion of more than 10,000 cubic feet per second for the Chicago Drainage Canal.

Two editions of this report were printed as a War Department document, and were distributed to all persons applying for them. A copy is hereto appended. (Appendix I.)

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DAM AT THE OUTLET OF LAKE ERIE.

32. The organic act creating the commission prescribed as one of its duties that it should 'report upon the advisability of locating a dam at the outlet of Lake Erie with a view to determining whether such dam will benefit navigation.' It so happens that the term 'dam' may apply to various works of which the character and object are very different. At the time of passing the act

Congress had before it the report of the board of engineers upon deep waterways between the Great Lakes and Atlantic tide-waters, dated June 30, 1900, in which it was recommended that the level of Lake Erie be 'regulated'-that is, that its oscillations be reduced-by means of a submerged weir in connection with a set of sluice gates placed at its outlet near the head of Niagara River. It seemed probable that this was the kind of works which Congress had in mind when using the term 'dam.' Their object would be to raise the low-water surface of the lake without raising the high-water surface. term 'dam' may also be applied to a submerged weir without sluice gates, the object of which would be simply to raise the level of the lake without reducing its oscilla-The low-water surface would be raised, but so would the high-water to nearly an equal amount. To distinguish works of this kind from those designed to 'regulate' the lake, they may be called 'compensating works.'

33. The Great Lakes, with their connecting channels, constitute the most important system of inland navigation in the world. The traffic which passed through Detroit River, its busiest link, in 1907, amounted to 71,226,895 tons, valued at about \$700,000,000 (the traffic of the most important river in Europe, the Rhine, was in 1905, about 4,000,000 tons). About 80 per cent. of this traffic is carried in large freight carriers which are loaded down to the greatest draft that can be carried into the harbors or through the channels between the lakes, but could be loaded much deeper if the depth of water permitted. Some of the larger of these vessels carry an additional load of 85 tons for each inch of additional draft. Every inch added to the available depth of water would

therefore be of material benefit to commerce.

34. The Great Lakes constitute a series of enormous natural reservoirs, each of which serves to regulate the flow in the river constituting its outlet and to maintain the lake below. They are interdependent. The study of one, to be complete, must include the study of all. The total area drained by them is about 287,688 square miles, an area considerably larger than the German Empire. Of this total about one-third is occupied by the lakes themselves—that is, devoted to reservoir purposes. The result is a uniformity of level and a uniformity of flow which are truly wonderful—a perfection of regulation

which no work of man ever did or ever will approach. The question propounded was, Could he add to any important extent to the degree of regulation which nature provided? Enormous forces were to be dealt with, and the results were to be measured in inches. The subject

was therefore as difficult as it was important.

35. Soon after the organization of the commission, a committee of two of its engineer members was appointed to collect all of the available data and to make an hydraulic analysis of the general regulation of all the lakes. It was well known at the outset that this would be a long and laborious task, but it proved to be more so than was expected, and the death of a member of the committee, Mr. Wisner, in 1906, was the cause of considerable delay. All existing records of water-level observations and discharge measurements made since 1860 were collected, analyzed, tabulated, and studied. By the end of 1909 the commission was able from these studies to form an opinion as to the first kind of works covered by the term 'dam'; that is, regulating works. The conclusions then reached were that only a very moderate degree of improvement in regulation over what nature provides is practicable in any of the lakes, and that such as it is, this improvement is obtained at the expense and to the injury of the navigable channels below. In the case of Lake Erie, it would be possible to raise the extreme low-water stages about 1 foot, and this in turn would raise the low-water stages of Lake St. Clair about 0.61 foot, and of Lake Huron-Michigan about 0.27 foot, all without appreciable increase in the extreme high stage. But in doing this the low-water stage of Lake Ontario would be lowered about 41 inches, the available depth in the St. Lawrence canals would be diminished about 7 2/3 inches, and the city of Buffalo would suffer by increased damage from floods and from a postponement of the date of opening navigation in the spring. The question of damage to vested rights was thus introduced in a particular intricate form.

While the advantages of regulation might outweigh the disadvantages if the persons who were to benefit from the former were identical with those who were to suffer from the latter, the difference was not great enough to justify the two Governments in entering upon the vexatious question of damages. The commission therefore

decided to recommend that the 'regulation' of Lake Erie be not undertaken and to proceed to the consideration of the other kind of works covered by the term 'dam' or compensating works. As this would require surveys and investigations which would cover many months, it decided also to submit to the two Governments without further delay the data which it had collected and the conclusions which it had reached concerning one branch of the subject committed to it. This it did in its report dated January 8, 1910. The report was forwarded to Congress by the President and was published as House Document No. 779, Sixty-first Congress, second session. An edition was printed also for the use of the commission, at the joint expense of the Canadian and American sections. The report is accompanied by 42 tables, many of them of elaborate character, and by 29 plates. An examination of it will give an idea, though a faint one, of the amount

of time and labor expended upon it.

36. There remained to be considered the other kind of works covered by the term 'dam' or compensating works. The Niagara River at its extreme upper end is an important safety valve for the protection of Buffalo from the effect of storms upon Lake Erie, and should not be obstructed by a dam, but it was believed that somewhere in the river between Lake Erie and the Falls a submerged dam might be placed which would greatly benefit the navigation of the waters above without injury to those below, and with only minor damages, if any, to the adjoining lands. Without any attempt to 'regulate' Lake Erie, the general level of the lake might be raised sufficiently to compensate for the damages heretofore inflicted by the Chicago Drainage Canal and other deteriorating influences. To determine the best site for such a dam it has been necessary to make additional surveys. To determine the best form for this dam, which must be of the submerged type, a large number of experiments upon several different forms was necessary. These experiments were made at the hydraulic canal of the college of civil engineering of Cornell University, the use of which was given free of expense. The results of these experiments were very satisfactory and they will be given in the report soon to be submitted. It was hoped that this work would be completed and a final report rendered before this time, but the illness of a member of the committee, Mr. Coste, and his absence in Europe, has caused an unexpected delay."

EXTRACT ENTITLED APPENDIX I ATTACHED TO THE INTERNATIONAL WATERWAYS COMMISSION PROGRESS REPORT ABOVE MENTIONED.

Page 67:

"Report Upon the Chicago Drainage Canal by the Commission, January 4, 1907.

International Waterways Commission, Toronto, Ontario, January 4, 1907.

The Honorable Secretary of War of the United States and the Honorable Minister of Public Works of Canada:

The International Waterways Commission has the honor to submit the following report upon the Chicago

Drainage Canal:

1. The headwaters of the Illinois River, an important tributary of the Mississippi, approach within 10 miles of Lake Michigan near its southerly end, where stands Chicago. The river, called here the Des Plaines, is separated from the lake by a low and narrow divide running nearly north and south. In the divide are two depressions, about 8 miles apart, in which the height is only about 10 feet above the surface of the lake. The area eastward of the divide is drained by two streams, the Chicago and the Calumet Rivers, which empty into Lake Michigan.

The City of Chicago was originally built on the Chicago River, and, although it is now spreading into the Calumet region, it was for many years drained ex-clusively by the Chicago River, and its principal parts are now so drained. This river constitutes the main sewer of Chicago. The lake furnishes the city's water supply. To prevent the pollution of the water supply by sewage has always been the most important municipal problem with which Chicago has had to deal. Its solution has from a very early day been found in diverting a part of the river's flow into the valley of the Des Plaines through the most northerly of the two depressions mentioned above. The Illinois and Michigan Canal, which opened to navigation in 1848, was at once utilized for this purpose, and all subsequent improvements consisted in efforts to force more sewage through that canal until, in 1889, it was decided to build a new and greatly enlarged

channel which should completely divert the Chicago River from Lake Michigan and draw from that lake a body of pure water large enough to make the sewage inoffensive

to the communities by whose doors it must pass.

Before embarking upon this work the city in 1886 appointed a commission of three engineers 'to consider and report on any and all things which relate to the matter of water supply and drainage of the City of Chicago.' In January, 1887, the commission submitted a report to the mayor and city council of Chicago (copy appended marked 1), which it styled a preliminary report. It intended to submit an additional or final report in which the data upon which its conclusions were based should be given in greater detail, but such additional report was never submitted. After remarking that 'almost every conceivable way of dealing with these questions had been suggested and in some form applied during the past thirty years,' the commission stated that 'among the possible methods of getting rid of the Chicago sewage there are but three that have been deemed worthy of consideration, namely, a discharge into Lake Michigan, a disposal upon land, and a discharge into the main river.' It considered the first method too expensive, involving as it does a wide separation between the outlets of the sewers and the intakes of the water supply. It pronounced the second inapplicable to the metropolitan district as a whole, under the topographical conditions existing, but thought that it might be employed for the extreme northern and southern parts, the latter including the Calumet region. It recommended the third method. It was uncertain as to the quantity of water required to dilute the sewage so as to make it inoffensive, but in order to prepare an estimate of cost it was compelled to assume some approximate size of channel, and it did assume a size large enough to discharge 600,000 cubic feet per minute, that being the estimated amount of water falling upon the area tributary to the Canal during storms and not otherwise disposed of. It includes the drainage basis of the upper Des Plaines and of the Chicago Rivers, but not that of the With a channel of less dimensions in Calumet River. times of storms and floods the Chicago River would not be fully diverted into the Des Plaines, but would back up into Lake Michigan. The result was a supply of 24,000 cubic feet per minute for each 100,000 people in a population of 2,500,000, the population which the commission thought it desirable to provide for, and the opinion was expressed that this would equal the maximum requirements.

3. Following this report the Illinois Legislature passed an act approved May 29, 1889, 'to create a sanitary district and to remove obstructions in the Des Plaines and Illinois Rivers,' of which the twenty-third and twenty-fourth paragraphs read as follows, viz:

'Paragraph 23. If any channel is constructed under the provisions hereof by means of which any of the waters of Lake Michigan shall be caused to pass into the Des Plaines or Illinois Rivers, such channel shall be constructed of sufficient size and capacity to produce and maintain at all times a continuous flow of not less than 300,000 cubic feet of water per minute, and to be of a depth of not less than 14 feet, and a current not exceeding 3 miles per hour, and if any portion of any such channel shall be cut through a territory with a rocky stratum where such rocky stratum is above a grade sufficient to produce a depth of water from Lake Michigan of not less than 18 feet, such portion of said channel shall have double the flowing capacity above provided for, and a width of not less than 160 feet at the bottom capable of producing a depth of not less than 18 feet of water. If the population of the district draining into such channel shall at any time exceed 1,500,000, such channel shall be made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cubic feet of water per minute for each 100,000 of the population of such district, at a current of not more than 3 miles per hour, and if at any time the General Government shall improve the Des Plaines or Illinois Rivers, so that the same shall be capable of receiving a flow of 600,000 cubic feet of water per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow above 300,000 cubic feet of water per minute from such channel may cause to private property so as to save harmless the said district from all liability therefrom, then such sanitary district shall, within one year thereafter, enlarge the entire channel leading into said Des Plaines or Illinois Rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cubic feet of water per minute, with a current of not more than 3 miles per hour, and such channel shall be constructed upon such grade as to be capable of producing a depth of water of not less than 18 feet throughout said channel, and shall have a width of not less than 160 feet at the bottom. In case a channel is constructed in the Des Plaines River, as contemplated in this section, it shall be carried down the slope between Lockport and Joliet to the pool, commonly known as the upper basin, of sufficient width and depth to carry off the water the channel shall bring down from above. The district constructing a channel to carry water from Lake Michigan of any amount authorized by this act may correct, modify and remove obstructions in the Des Plaines and Illinois Rivers wherever it shall be necessary so to do to prevent overflow or damage along said rivers, and shall remove the dams at Henry and Copperas Creek, in the Illinois River, before any water shall be turned into the said channel. And the canal commissioners, if they shall find at any time that an additional supply of water has been added to either of said rivers by any drainage district or districts, to maintain a depth of not less than 6 feet from any dam owned by the State to and into the first lock of the Illinois and Michigan Canal at La Salle, without the aid of any such dams, at low water, then it shall be the duty of said canal commissioners to cause such dam or dams to be removed. This act shall not be construed to authorize the injury or destruction of existing waterpower rights.

'Paragraph 24. When such channel shall be completed, and the water turned therein, to the amount of 300,000 cubic feet of water per minute, the same is hereby declared a navigable stream, and whenever the General Government shall improve the Des Plaines and Illinois Rivers for navigation, to connect with this channel, said General Government shall have full control over the same for navigation purposes but not to interfere with

its control for sanitary or drainage purposes.'

By this act a flow of not less than 20,000 cubic feet per minute is required for each 100,000 inhabitants and provision is made for a population of 3,000,000. The evidence before the legislative committee which framed the bill as to the quantity required was contradictory. The amount fixed for dilution of the sewage was a minimum.

(See Appendix I₂.)

4. Under this act the Sanitary District of Chicago was organized, embracing all of the city north of Eightyseventh street and some 43 square miles of Cook County outside of the city limits. The total area of the district was 185 square miles and did not include the Calumet region nor the north shore. The trustees held their first meeting January 18, 1890. The Chicago Drainage Canal was then constructed, water being turned into it for the first time in January, 1900. It was not then, and has not since been, completed to its full capacity as designed. In some places where the excavation was in rock the full dimensions of the prism were taken out, but in earth a considerable volume was left to be removed by the easy method of dredging hereafter. When fully completed it was designed to have a capacity of 600,000 cubic feet per minute, or 10,000 cubic feet per second, flowing at a velocity of 1.25 miles per hour in earth and 1.9 miles per hour in rock.

5. The canal is 28.05 miles in length. For a distance of 7.8 miles from its junction with the Chicago River at Robey street its dimensions are 110 feet width at bottom, side slopes 1 on 2, depth of water 22 feet at low stage of Lake Michigan, with a grade of 1 in 40,000, the material being earth. This section is eventually to have a width

of 200 feet at bottom.

6. For a farther distance of 5.3 miles, although the material is principally earth, the dimensions are 202 feet width at bottom, side slopes 1 on 2, minimum depth of water 22 feet, with a grade of 1 in 40,000. This section

is completed.

7. For the remaining 15.95 miles the canal is excavated wholly or partially in rock. Where the natural rock does not come to the surface walls of masonry have been built upon the rock surface, thus artifically carrying it to a height 5 feet above datum. The dimensions here are 160 feet width at bottom, 162 feet width at top, minimum depth of water 22 feet, with a grade of 1 in 20,000. This section also is completed.

8. The controlling works are situated near the town of Lockport at the western end of the canal. They consist of a bear-trap dam 160 feet wide, with a vertical

play of 17 feet, and of seven sluice gates of the Stoney type, each 30 feet wide and having a vertical play of 20 feet. These works provide a very efficient means of con-

trolling the flow of water through the canal.

9. The project of the sanitary district for the disposal of sewage by the canal when completed is briefly as follows: All sewers will discharge into the Chicago River. either directly or through intercepting sewers. From the mouth in Lake Michigan to the point where the North and South Branches unite the river will flow 8,000 cubic feet per second, less such quantity as may be pumped into the upper portion of the North Branch, which under the original project was 200 cubic feet per second admitted through a conduit at Fullerton avenue. From this point the combined flow will be 8,000 cubic feet to the point where the South Fork enters the South Branch, where it will be increased to 10,000 cubic feet by water pumped from Lake Michigan at Thirty-ninth street and flowing through a large conduit in Thirty-ninth street to the South Fork. The volume which will finally enter the canal under this project will be 10,000 cubic feet per second.

10. The channel of the Chicago River is not large enough to transmit that volume from the lake to the canal except at velocities which are an obstruction to navigation. The amount which the Secretary of War has thus far permitted the sanitary district to pass through the river is 4,167 cubic feet per second. In order to obtain authority for a larger amount the trustees have undertaken to enlarge the channel of the river and have accomplished a large amount of work in that direction.

11. By act of the Illinois Legislature in 1903 the sanitary district was enlarged by annexing thereto the north shore district, containing 78.6 square miles, and the Calumet district, containing 94.48 square miles. The total area of the sanitary district is therefore now 358.08 square miles. The same legislature authorized the development

of the water power created by the diversion.

12. The plans for the north shore region involve two additional conduits from the lake to the North Branch of the Chicago River, one at Lawrence avenue, into which 583 cubic feet per second, and one at Wilmette, into which 1,000 cubic feet per second, are to be pumped. As this water is to form a part of the 10,000 cubic feet originally to be taken out through that river, it does not add

to the amount of water to be taken from Lake Michigan. The plans for the Calumet region involve a treatment of the Calumet River similar to that of the Chicago The river is to be diverted into the Des Plaines Valley. For this purpose a new channel is to be cut through the southerly depression in the divide, and to join the present drainage canal at Sag, about 11 miles from the controlling works at Lockport. From Sag to Lockport the drainage canal must carry the flow from the Calumet River in addition to that from the Chicago River. It was designed to accommodate the latter river alone, or 10,000 cubic feet per second, but improved methods of excavation, particularly channeling in rock, gave it a greater capacity than was computed; and the hydraulic formulae with which its dimensions were figured, being adapted to smaller streams, gave results which proved to be too large. It is found that the por-tion completed in rock, which includes the reach from Sag to Lockport, will carry an amount stated by the chief engineer to be 14,000 cubic feet per second. The difference, 4,000 cubic feet per second, is the amount which it is proposed to divert from the Calumet River. For this purpose it is proposed to excavate a channel having in earth a bottom width of 72 feet, with side slopes 3 on 5, and in rock a bottom width of 90 feet with vertical sides. the depth in both cases to be 25 feet.

14. Work in the territory annexed in 1903 has been limited to surveys, and the preparation of plans, and the expenditures in that territory have been small. The amount expended upon the drainage canal and accessory works, including the above, to December 31, 1905, is \$40,-873,629.71; in addition to which \$1,556,226.56 has been expended for the development of water power and \$7,-290,101.27 has been paid out for interest. For a financial

statement more in detail, see Appendix I.

15. Although the primary object of the Chicago Drainage Canal was the discharge of Chicago sewage, its function as a channel for navigation was kept in view from the beginning. All of the bridges over it are drawbridges with ample openings. A provision of this kind, as well as the care exercised to make the sewage inoffensive by liberal dilution, was necessary to conciliate the interests in the valley of the Des Plaines and Illinois River, which would otherwise be adversely affected. It can

hardly be doubted that the canal will eventually form a part of an improved waterway between the Great Lakes and the Mississippi River, though its full depth will probably not be required for that purpose. Congress has not adopted any scheme for this improvement, but by its direction a survey was made, and plans with estimates for a waterway 14 feet deep were submitted, by a board of engineers in a report dated August 26, 1905. The board found that for a distance of about 100 miles from Chicago the improvement must be with locks and dams, and as the quantity of water required would be merely that needed for the service of locks and other incidentals, the extent of the improvement of depth which could be obtained in that part of the route was without limit so far as it depended upon the amount of water available. For the remaining distance, about 223 miles, the improvement would be an enlargement of the open channel and the degree to which it was practicable was entirely dependent upon the quantity of water flowing. The board assumed that the Chicago Drainage Canal would eventually be permitted to take 10,000 cubic feet per second from Lake Michigan, and it expressed the opinion that with that volume added to the natural low-water discharge of the Illinois River a depth of 14 feet in the open channel could be maintained; also that if a much greater depth was to be secured a much larger volume of water must be taken from Lake Michigan.

16. In the neighborhood of Lockport the natural level of the ground falls away rapidly and excellent facilities are found for the development of water power. Under the state legislation of 1903 the sanitary district is now engaged in utilizing this incidental advantage of the drain-The plans provide for an extension of the canal 10,700 feet between concrete walls and earth and rock embankments to the site selected for the power house and for the excavation of a tail race 6,800 feet long. 160 feet wide, and 22 feet deep. If the maximum quantity of water which the sanitary district now claims to be necessary for sanitary purposes-14,000 feet per second—be utilized it will be possible to develop about 40,000 electrical horsepower under a head of 34 feet. With 10,000 cubic feet per second about 28,000 horsepower can be developed. A power house is being erected which will

accommodate 8 turbines, each capable of generating 5,000 horsepower.

17. The sanitary district has acquired land on both sides of the canal throughout its length, the width of the strips varying from 200 to 800 feet. This land is offered to manufacturers at moderate prices, and it seems probable that they will in the course of time be attracted thereto, particularly after arrangements for furnishing them with cheap power from Lockport are completed.

The diversion of large bodies of water from Lake Michigan for supplying the drainage canal has not been authorized by Congress. The plans of the sanitary district, except those for the enlargement of the Chicago River, have not been submitted to any Federal authority for approval. It was only after the opening of the canal that application was made to the Secretary of War for permission to divert the quantity of water required by the State law. The secretary granted permission for such quantity as would pass through Chicago River without detriment to navigation, a quantity considerably less than that required by the State law. After experimenting with various amounts it was fixed at 250,000 cubic feet per minute, or 4,167 cubic feet per second, and that is the amount now authorized. It is 'subject to such modification as, in the opinion of the Secretary of War, the public interests may from time to time require.' Copies of all the permits granted by the Secretary of War in this connection will be found in Appendix I4.

19. In the expenditure of \$40,000,000 for the drainage canal the people of Chicago, with its population of 2,000,-000 incurred a burden equivalent to that due to an expenditure of \$1,600,000,000 by the United States, with its population of 80,000,000—that is, enough to build eight or more Panama canals. It was a very serious effort and has commanded the admiration and sympathy of all observers. The diversion of 10,000 cubic feet per second from Lake Michigan affects other interests adversely, but these interests have withheld their opposition, seeming to believe that some such amount was necessary, and apparently willing to contribute their share to protect the lives and health of the people of a great city. The plans calling for that amount have been under public discussion for some years. Although withholding formal approval, the Federal authorities have taken no steps

to prevent their execution. Congress has called for a plan and estimates for an improvement of the waterways connecting with it, the scope of which is fixed by that amount. There appears to be a tacit general agreement that Chicago needs or will need about 10,000 cubic feet of water per second for sanitary purposes and that the

city should have it without further question.

20. It was not generally known until after the publication in March last of the report of the American section of this commission upon Niagara Falls that an amount greater than 10,000 cubic feet per second would be asked for. In that report, subsequently concurred in by the Canadian section, it was recommended that the diversion of 10,000 cubic feet be allowed. The preservation of Niagara Falls alone was considered, and that in the light of the tacit agreement above described. It was supposed at the time that this was all that Chicago needed, but the recommendation gave offense to the officials of the sanitary district, and the further demand then came out in the form of appeals to the committees of Congress and to the Secretary of State. It is necessary now to take up the question anew, and, after considering it in all its bearings, to reach some conclusion as to whether there should be a limit to the amount of water to be diverted at Chicago, and, if so, as to what that limit

21. That the abstraction of water from Lake Michigan has a tendency to lower the level of that lake and of all the waters to which it is tributary is self-evident; but the exact effect of abstracting a given amount can be ascertained only from prolonged observation of the natural outlets under the varying conditions to which they are subjected during a series of years. An elaborate investigation of this subject was made under the office of the United States Lake Survey in Detroit, the results of which were published in the annual reports of the Chief of Engineers for 1900, page 5401; for 1902, pages 2779 and 2825; and for 1904, page 4120. Further observations are needed to be made when the difference of the level between Lake Erie and Lake Huron is greater or less than when the existing observations were made, but the results obtained from the latter are believed to be reliable within one-tenth of a foot. The amounts by which the mean level, as derived from observations of the last 46

years of the various waters will be lowered by a discharge of 10,000 and also by 14,000 cubic feet per second are given in the following table:

Water level lowered by diversion at Chicago of—

fe	00 cubic et per second.	14,000 cubic feet per second.
	Foot.	Foot.
Lakes Huron and Michigan	0.52	0.70
Lake St. Clair	.45	.64
Lake Erie	.45	.64
Lake Ontario	.35	.49
St. Lawrence River at Rapids Plat		.56

From this table it appears that all the waters, including Lakes Michigan and Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence River, besides the important connecting channels, the Detroit and St. Clair Rivers, will be lowered by amounts varying from 4½ to 6½ inches for 10,000 cubic feet and from 6 to 8½ inches for 14,000 cubic feet per second. The length of time required to produce this effect is about 5 years; about half of it will be produced at the end of 18 months. The above figures give the effect at average level; they are much more

considerable during low-water periods.

22. Variations in the level of the lakes' surface, due to winds and to change of barometric pressure, are frequent and irregular and at times violent. Variations of more than 6 inches are very common, often occurring hourly for many hours in succession, while variations of 2 or 3 feet within an hour are not uncommon. Besides these irregular variations there is a regular annual variation due to difference in rainfall, evaporation, and runoff, the water level being highest in midsummer and lowest in midwinter. The levels are affected also by the greater or less severity of the winter and the consequent greater or less decreases in the discharging capacity of the outlets by ice. In order to study the annual oscillations it is necessary to eliminate the irregular oscillations, and that is accomplished by using the average levels

for a month. Using the monthly mean levels it is found that the regular fluctuation in Lake Huron-Michigan usually does not exceed 2 feet in any one year, but in a long series of years there is a great difference in the height to which high water will rise. The highest high water (monthly mean) recorded for that lake was in June, 1886, and the lowest high water in June, 1896, the difference between the two being over 3½ feet. The first is what navigators of the Great Lakes call a high-water

year and the second a low-water year.

23. It is evident that the average level of the lake may be lowered considerably without the change becoming immediately apparent, and that fact has been used as an argument to prove that the lowering caused by the Chicago Drainage Canal is of no consequence to those interested in navigation. Since they can not see it they will not know it and will not feel it. The argument is fallacious. It is true that they can not see it immediately, but they will soon feel it and will know it through the most costly means of acquiring knowledge—the injury to their material interests. The oscillations will remain the same as before, but low water will fall lower and high water will rise less high. The average draft of vessels must be diminished by the amount that the average level is lowered unless the depth be restored by remedial works.

The most important lake traffic is now carried 24. on in large freight carriers which are loaded down to the greatest draft that can be carried into the harbors or through the channels between the lakes. With the depth now available they are usually loaded to a draft of about 19 feet, but careful watch is kept on the stage of the waterways and advantage is taken of any temporary increase of stage to load the vessels deeper. In the modern vessel each inch of increased draft adds about 50 tons to the carrying capacity. To lower the water surface 6 inches is to reduce the capacity of the vessel about 300 tons. If the freight rate on iron ore be taken at 55 cents per ton, exclusive of the cost of loading and unloading, and the number of trips during the season at 22, there appears a loss of over \$3,600 for the season for each vessel. The number of vessels navigating the Great Lakes which draw 19 feet or more is 417, and their tonnage is 1,541,414 tons, which is about three-quarters of

the total tonnage of the Great Lakes. It is a conservative estimate that the loss to the navigation interests resulting from a reduction of 6 inches in the depth of water is \$1,500,000 per annum, which capitalized at 4 per cent., amounts to a loss of \$37,500,000. With a greater reduction of depth the resulting loss would be proportionately The number of deep-draft vessels and the greater. share of lake traffic which they carry is increasing each year, while the lake traffic itself is increasing with marvelous rapidity. The total number of tons of freight which passed through Detroit River in 1905 was about 58,000,000, valued at about \$615,000,000. The records for the year 1906, so far as they are made up, indicate that the number of tons which passed through the Detroit River in 1908 exceeded 65,000,000, valued at \$690,000,000. The loss will be even greater in the future than it is now. It is quite certain that the loss will not pass unnoticed, and that the Governments will be compelled to restore the depth either by additional excavations or by regulating works.

25. Careful estimates have been made of the cost of deepening the channels between the lakes 1 foot. To deepen the Detroit River is estimated to cost \$4,115,430. In Lake St. Clair the full depth of the lake is now utilized, and any lowering of its surface involves the excavation of an artificial channel entirely across the lake, a distance of 18 miles, of which it has been necessary heretofore to artificially deepen only one-third. To deepen the channel here and at certain shoal places in St. Clair River and at the foot of Lake Huron is estimated to cost \$1,080,720. It results in replacing open lake navigation by canal navigation for a distance of 12 miles in Lake St. Clair, a decided disadvantage.

26. The data are not at hand for an accurate estimate of the cost of restoring the depths in the harbors of the Great Lakes, but an approximation may be reached from a consideration of the cost of improvements heretofore made. The depth to be gained being small, the cost will not vary largely, whether that gain be a few inches more or less. The United States has improved 35 harbors on Lake Michigan, Huron, Erie, and has expended thereon about \$20,000,000, of which about one-quarter was for maintenance. The average increase of depth is 10 feet and the cost per foot of increase was therefore about

\$1,500,000, but as the cost of a small increase would be much greater per foot than an increase of 10 feet, and as several harbors on Lake Ontario are to be added, the cost per foot in this case would probably be not less than \$2,000,000 for harbors in the United States. The Canadian Government has improved over 50 harbors on Georgian Bay, Lake Huron, St. Clair, Erie and Ontario. A large amount, say \$3,000,000, must be added for increas-

ing the depth of these harbors.

27. The depth in the Welland Canal and in the six canals employed to overcome rapids in the St. Lawrence River is now 14 feet, of which every inch is needed. At the head of the Cornwall Canal in the St. Lawrence River the abstraction of 14,000 cubic feet of water per second at Chicago will lower the surface about 63 inches at mean level and much more at low water. To restore the depth in these canals involves the reconstruction of all the end locks and deepening the approaches thereto, and is estimated to cost \$2,500,000.

28. The total cost of restoring the depth in the harbors of the Great Lakes and the channels between the lakes is therefore roughly \$10,000,000, and of restoring it in the Welland and St. Lawrence Canals is \$2,500,000

additional, or \$12,500,000 in all.

29. The shores of the Great Lakes are very far from being fully developed, and it is highly probable that many harbors not now in existence remain to be created, or if in existence remain to be improved. The lowering of the lakes' surface increase the difficulty and cost of such improvements. This consideration is of importance, al-

though no money value can now be given it.

30. The expenditure of the sums mentioned above will restore the depths now existing, but it will not prevent very serious annoyance to the navigation interests during the execution of the work. The time required will be several years, and in the meantime the vast commerce of the Great Lakes will be hampered, not only by deficient depth, but also by the occupation of the channels, already crowded with commerce, by the excavating machines.

31. It is evident from the foregoing that large bodies of water cannot be diverted by the Chicago Drainage Canal without very serious detriment to the navigation interests of the Great Lakes and of the St. Lawrence Valley. The greater the amount of water diverted the greater

the injury. Chicago being one of the principal lake ports, there will be very few communities which will feel this detriment more than she will.

32. In the presence of these interests, the effect upon Niagara Falls may be simply mentioned with a reference to our former reports upon that subject. The volume of Niagara Falls will be reduced by the full amount diverted

at Chicago.

33. The City of Chicago was organized as a city in 1837 with a population of about 4,000. Its population in 1840 was 4,479; in 1850, 28,269; in 1860, 112,172; in 1870, 298,977; in 1880, 503,185; in 1890, 1,099,850; and in 1900 it was 1,698,575. It is estimated now to be about 2,000,-Should the rate of growth continue which prevailed between 1880 and 1900, the population will be 3,000,000 in the year 1922 and 4,000,000 in the year 1939. It is impossible to foretell its future growth, but there is no reason to doubt that it will in time greatly exceed the largest of these numbers. The city is the commercial center of an empire still in its infancy. It is entirely reasonable to expect a population of five or six millions or more. It will cover territory not now covered. Methods of sewage disposal appropriate to one portion of it may not be appropriate to other portions. If the diversion of 20,000 cubic feet per minute (or 3334 cubic feet per second) for each 100,000 of population, as required by the State law, is accepted as the standard, then from 17,000 to 20,000 cubic feet per second will be required, and the 14,000 cubic feet now contemplated will not be Even more than 20,000 cubic feet will be resufficient. quired for a population greater than 6,000,000. version of 20,000 cubic feet per second would lower Lakes Michigan and Huron about 13 inches and Lake Erie about 11 inches. Plans which lead to this result should be carefully scrutinized.

34. One of the reasons given in 1889 for adopting this method of disposing of Chicago sewage was that it offered the advantage of furnishing a navigable waterway from Chicago to the Mississippi River. The navigable depth or capacity of such a waterway has never been authoritatively fixed. Congress has considered a depth of 14 feet to the extent of ordering a survey and estimates of cost for that depth, but the Illinois legislature has declared its policy to be to secure the construction of a deeper channel, not limiting its proposed capacity in

terms, but defining it to be 'of the greatest practicable depth and usefulness for navigation.' See joint resolution adopted May 27, 1889, copy omitting preamble here-to appended, marked 'I₅.' A fair interpretation of this language gives a proposed depth of 20 feet, that being the depth required to accommodate the most important vessels now navigating the Great Lakes. It will require a volume of water greater than the 10,000 cubic feet per

second originally contempated.

35. The amount which it is proposed to divert from the Calumet River 4,000 cubic feet per second, is fixed by accident rather than by design, being the excess which the Chicago Drainage Canal is found capable of carrying after providing for the 10,000 cubic feet from the Chicago River, for which it was originally constructed. It is certain that no greater amount than 4,000 cubic feet can be diverted from the Calumet without checking the flow from the Chicago River, and thus giving relief to a suburban portion of the city at the expense of the richest

and most populous centers.

36. It is equally certain that the diversion of 4,000 cubic feet or less will not at all times afford the desired relief to the Calumet. In the first place, it provider for a population of only 1,200,000, a number which will in all probability be greatly exceeded at a day not remote. present the population is estimated at about 200,000, but for the present necessities it is not a question of population, but of drainage area and rainfall. charge of the Calumet has been measured at Riverdale, about 10 miles from its mouth, of about 13,300 cubic feet per second from a drainage area of about 700 square miles, and even that amount may at times be exceeded. The total drainage area of the Calumet region, including the Sag Valley, is about 825 square miles, and assuming the discharge to increase in proportion to the area, the flood discharge to be provided for is over 15,700 cubic feet per second. The diversion of only 4,000 cubic feet will not prevent a heavy discharge into Lake Michigan in time of flood. To overcome this difficulty it is proposed, if suitable legislation can be secured, to divert the upper Calumet into Lake Michigan through an artificial channel to be excavated in Indiana about 174 miles east of the Indiana has not authorized such diversion, but supposing it to be accomplished, there will still be times when the discharge from the drainage area remaining to be cared for by the canal, 238 square miles, will exceed 4,000 cubic feet per second. The excess must enter Lake Michigan through the mouth of the Calumet, and at such times the system will fail. Of course it makes no provision for the future occupation of the upper Calumet region and the pollution of the lake from that source. It thus appears that the diversion of the Calumet River as now proposed by the Sanitary District will not be complete even for the present, and will not make adequate

provision for the future.

37. The diversion of 4,000 cubic feet per second provides for a population of 1,200,000 by the standard fixed by the State law. The population of the Calumet region is now about 200,000, and until it reaches 1,200,000 only a part of the flow will be needed for sanitary purposes during a large part of the year; but the channel must be there, available for the full flow, if this method of sewage disposal is to be useful to any population, however Likewise the channel from the Chicago River small. must be, as it is, large enough to provide for a population of 3,000,000, whether that number of people are ever to become tributary to the Chicago River or not. The channels having once been constructed, any reduction of flow below their fullest capacity is a dead loss to the water power dependent upon them. It has been said that it would be absurd to develop water power at the cost per horsepower which this water power costs if the drainage canal be included, and that is true. But being given the channels, it would not be absurd to use them to their fullest capacity. The Chicago Drainage Canal having been constructed, with a capacity, as it turns out, of 14,000 cubic feet per second, full power development will call for the whole of that amount, and in fact power works are now under construction at Lockport to utilize it. Inasmuch as the sanitary requirements by the standard fixed in the State law are only 6.667 cubic feet per second for the present population of 2,000,000, it is evident that power development incidental though it be, does lead to demands for water not required for sanitary purposes.

38. It remains to be seen whether any diversion, complete or otherwise, is necessary to preserve the health of Chicago. Upon this point the commission sought the advice of two eminent sanitary engineers—Messrs. Budolph Hering and George W. Fuller—whom it instructed as follows, viz.: 'To examine the sanitary situation at Chi-

cago, so far as it is affected by sewage disposal, and to report whether it is or is not necessary to the health of the city to extend to outlying territory the system which was adopted in 1889 for the main city. commission desires an emphatic opinion from authoritative sources as to whether the system of diverting the water of Lake Michigan in large quantities into the Illinois Valley is the only way to preserve the lives and health of the people of Chicago. It does not desire an investigation of the effect upon the navigation interests of the Great Lakes. It has satisfied itself upon that point. Nor does it wish to reopen the case of the Chicago Drainage Canal as designed and built. It accepts that as a fixed fact, with its attendant diversion of 10,000 cubic feet per second through the Chicago River. extension of the system to the Calumet River alone is in question, and the question is, Are there not other methods of sewage disposal which can be applied here at a cost not exceeding much, if at all, the cost of the method proposed, and which will be equally effective in preventing the pollution of the lake? It desires a report upon the various systems which may be found available for application here, with a statement of their relative efficiency. It also desires a statement of their relative cost, so far as that can be given without the preparation of The latest conclusions of sanitary engidetailed plans. neers as to the amount of dilution which is required to make sewage inoffensive should be given.' These gentlemen visited Chicago, and after a thorough examination of the situation submitted a report, of which a copy is hereto appended, marked 'I₆.' The entire report should be carefully studied. Its conclusions only are here quoted. They are as follows, viz.:

'The latest conclusions of sanitary engineers as to the amount of dilution which is required to make sewage inoffensive are that a dilution of 3½ cubic feet per second for each 1,000 persons connected with the sewers, as provided for in the enactment of the Illinois legislature in 1889, is as low a figure as it is now possible to state. We believe that with the elimination of objectionable trade wastes and the occasional dredging of the river this amount of dilution will be sufficient to prevent offensive-

ness.

The extension of the dilution method to the outlying territory is not the only way to preserve the lives and

17.637,500

health of the people of Chicago. The application of the method, with flow of 10,000 and 14,000 cubic feet per second, respectively, for the area tributary to the present drainage canal, will serve populations not exceeding 3,000,000 and 4,200,000, respectively. For greater populations other methods of sewage disposal will be required.

For the Calumet area, as well as other districts, there are several methods for the disposal of sewage as effective as the present method of dilution in preventing the

pollution of the lake waters.

All these methods involve intersecting sewers and pumping stations to collect and deliver the sewage at suitable sites. Septic tanks are used for partially clarifying the sewage, which may then be applied to any one of three methods, of filters, viz.: intermittent sand filters, contact

filtersand sprinkling filters.

All of these filters if well built and well managed remove the suspended and organic matters so that the effluents are practically clear and nonputrescrible. The removal of bacteria by these three types of filters average at least 98, 80 and 90 per cent., respectively. Such effluents may be discharged into any of the water courses of the Calumet region.

The approximate total costs, liberally estimated, without the preparation of detailed plans, for a population of

1,200,000 are as follows:

1,200,000 are as follows:	
A—Intermittent Sand Filters. Construction	\$11,063,000 17,320,000
	28,383,000
B—Contact Filters. Construction Annual cost of operation, \$551,000, capitalized at 5%	\$11,787,500 11,020,000 22,807,500
C—Sprinkling Filters. Construction Annual cost of operations, \$419,000, capitalized at 5%	\$ 9,257,500 8.380,000

The present population on the Calumet area of the sanitary district being less than 200,000 would naturally require but a portion of the cost of estimated works and of

their operation to be expended at the outset.

Of the available methods of disposing of the sewage of the Calumet area other than by dilution, the sprinkling filter method, being the cheapest both in cost of construction and of operation and accomplishing an adequate degree of purification, is clearly the most advantageous one.

These engineers stand in the front rank of their profession as sanitary experts. One of them, Mr. Hering, was chairman of the commission of 1887, whose report to the mayor and city council of Chicago was the foundation of the subequent legislation and led to the construction of the drainage canal. The conclusions reached are those of friends of Chicago and not of her enemies or rivals.

39. A method of sewage disposal for the Calumet region is proposed which for a population of 1,200,000 is estimated to cost \$17,637,500. For the present population of about 200,000 only a part of the expense need be incurred, and the works can be developed as the population It can, when the necessity arises, be applied plation much exceeding 1,200,000. The cost of with a population much exceeding 1,200,000. diverting the Calumet River into the Chicago Drainage Canal is estimated at \$12,000,000. The greater efficiency at present and in the future of the method now proposed would justify a considerable increase of cost, but in view of the fact that the entire expense of the diversion must be incurred at the outset, while by the new method the expenditures will be regulated by the growth of population, the difference in cost may be considered unimportant.

SUMMARY.

40. The following is a summary of the more impor-

tant facts recited in this report:

(a) Chicago obtains its water supply from Lake Michigan, and to avoid polluting it must either dispose of its sewage otherwise than in the lake or place its intakes for water at a great distance from the city.

(b) The topography of the country favors the discharge of the sewage into the Des Plaines River, a tributary of the Mississippi, through two depressions in the divide which separate that river from Lake Michigan.

(e) The slope on the lake side of the divide is drained

by two streams—the Chicago River and the Calumet River—into which the sewers of the city empty. By a cut through the northerly depression the flow of the Chicago River has been reversed and diverted into the Des Plaines River instead of into Lake Michigan, and by a cut through the southerly depression the same process can be applied to the Calumet River.

(d) To make this reversal effective the channels must be large enough to take all the water which falls upon the respective drainage areas during the most violent rainstorms. This amount is estimated at 10,000 cubic feet per second for the Chicago River and 15,700 cubic

feet per second for the Calumet River.

(e) The City of Chicago was originally built upon the Chicago River, and that stream now drains the richest and most populous part of the city. It is now spread-

ing over the Calumet region.

(f) In 1889 the plan of diverting the Chicago River into the valley of the Des Plaines was definitely adopted, and the Chicago Drainage Canal was undertaken. It was designed to carry 10,000 cubic feet per second. Though not entirely completed, it has been in use since January, 1900. The amount expended upon the canal and acces-

sory work is about \$41,000,000.

(g) The Illinois law which authorized the canal required a flow of 333 cubic feet per second for each 100,000 of population in order to render the sewage inoffensive. This amount of dilution is probably not excessive. It is reasonable to expect a population in a future not remote of five or six millions or more, involving the diversion by this standard of some 20,000 cubic feet per second. The Chicago River with its 10,000 cubic feet provides for a population of 3,000,000. The present population of the city is about 2,000,000.

(h) It is now proposed to apply to the Calumet River a treatment similar to that applied to the Chicago River, viz.: to reverse its flow, so that instead of discharging into Lake Michigan it shall discharge into the Des Plaines, but for a part of the new route it must follow the drainage

canal already excavated for the Chicago River.

(i) Although the Chicago Drainage Canal was designed to carry 10,000 cubic feet per second, it is found to have, in its completed rock portion, an actual capacity of 14,000 cubic feet. This additional capacity fixes the amount which it is proposed to divert from the Calu-

met at 4,000 cubic feet per second. Any greater amount from the Calumet will overtax the drainage canal at the expense of the richest part of Chicago and for the benefit

of a suburban part.

(k) The diversion of only 4,000 cubic feet will not be effective at all times, since a much greater amount must be diverted from the Calumet during heavy rainstorms if the lake is to be protected. Moreover, it provides for a population not exceeding 1,200,000, which number will probably be exceeded at a date not far distant.

(1) The large channels necessary to provide for the contingencies of rainstorms are capable of discharging a volume of water largely in excess of sanitary requirements during the greater part of the year, but the development of water power creates the demand that they be employed to their full capacity throughout the year.

(m) The diversion of large bodies of water from Lake Michigan for supplying the drainage canal has not been authorized by Congress, but there appears to be a tacit general agreement that no objection will be made to the diversion of 10,000 cubic feet per second, as originally

planned.

(n) The diversion of 10,000 cubic feet per second will lower the levels of Lake Michigan-Huron, Lake St. Clair, Lake Erie, Lake Ontario, and the St. Lawrence River, besides the important connecting channels, the Detroit and St. Clair Rivers, by amounts varying from 4½ to 6½ inches for the different waters, and the diversion of 14,000 cubic feet will lower them from 6 to 8½ inches. The diversion of 20,000 cubic feet will lower Lake Michigan-Huron about 13 inches and Lake Erie about 11 inches.

(o) The lake traffic which passed through the Detroit River in 1905 was about 58,000,000 tons, valued at about \$615,000,000. It is increasing annually with marvelous rapidity. The records for the year 1906, so far as they are made up, indicate that the number of tons which passed through the Detroit River in 1906 exceeded 65,000,000, valued at \$690,000,000. The lowering of the water surface has a very injurious effect upon this traffic and upon that of the Welland and St. Lawrence Canals. Chicago being one of the principal lake ports, there will be very few communities which will feel the injury more than she will.

(p) The cost of restoring the depth in the harbors of the Great Lakes and the channels between the lakes is estimated at \$10,000,000, and of restoring it in the Welland and St. Lawrence Canals at \$2,500,000. This expenditure would not prevent very serious annoyance to the navigation interests during the execution of the remedial works, which would occupy several years. In Lake St. Clair navigation of the open lake would be replaced by that of an artificial channel or canal with submerged banks.

(q) The extension to the Calumet region of the method of sewage disposal already applied to the Chicago River is not necessary to preserve the health of Chicago, there being other and better methods available for the Calumet region. The final cost of these methods is somewhat greater than that of the one proposed, but the works can be developed as the population increases, and only a part of their cost need be incurred at present, while their greater efficiency justifies the increase of final cost.

(r) The diversion of 10,000 cubic feet of water per second at Chicago will render practicable a waterway to the Mississippi River 14 feet deep. Any greater depth must be obtained by the abstraction of more water from Lake Michigan and at the expense of the navigation interests of the Great Lakes and of the St. Lawrence Valley.

(s) The effect upon Niagara Falls of diverting water at Chicago is of secondary importance when considering the health of a great city and the navigation interests of the Great Lakes and of the St. Lawrence Valley, but it is proper to note that the volume of the falls will be diminished by the full amount diverted at Chicago.

RECOMMENDATIONS.

41. The waters of Lake Michigan in the United States, the waters of Georgian Bay in Canada, and the waters of Lake Superior partly in the United States and partly in Canada all form sources of supply of the Great Lakes system, finding their way by the St. Lawrence to the sea. All are interdependent and there can be no diversion from any of them without injury to the whole system. By Article XXVI of the treaty of 1871 it is provided that 'navigation of the river St. Lawrence, ascending and descending from the forty-fifth parallel of north latitude,

where it ceases to form the boundary between the two countries, from, to, and into the sea, shall forever remain free and open for the purposes of commerce to the citizens of the United States, subject to any laws and regulations of Great Britain, or of the Dominion of Canada, not inconsistent with such privileges of free navigation.' It is desirable that in any treaty arrangement the waters of Lake Michigan, Georgian Bay, and all other waters forming part of the Great Lakes system should be declared to be 'forever free and open for the purposes of commerce' to the citizens of the United States and the subjects of His Britannic Majesty, subject to any laws and regulations of either country not inconsistent with

such privilege of free navigation.

The preservation of the levels of the Great Lakes is imperative. The interest of navigation in these waters is paramount, subject only to the right of use for domestic purposes, in which term is included necessary sanitary purposes. In our report of November 15, 1906, upon the application of the Minnesota Canal & Power Co. to divert certain waters in Minnesota, we recommended, among other things 'that any treaty which may be entered into should define the uses to which international waters may be put by either country without the necessity of adjustment in each instance, and would respectfully suggest that such uses should be declared to be (a) uses for necessary domestic and sanitary purposes; (b) service of locks for navigation purposes; (c) the right to navigate.' It is our opinion that so far as international action is concerned a treaty provision of that kind is all that is required in this case. We accordingly renew our recommendation of November 15, 1906, just quoted.

43. A careful consideration of all the circumstances leads us to the conclusion that the diversion of 10,000 cubic feet per second through the Chicago River will, with proper treatment of the sewage from areas now sparsely occupied, provide for all the population which will ever be tributary to that river, and that the amount named will therefore suffice for the sanitary purposes of the city for all time. Incidentally it will provide for the largest navigable waterway from Lake Michigan to the Mississippi River which has been considered by Congress.

We therefore recommend that the Government of the

United States prohibit the diversion of more than 10,000 cabic feet per second for the Chicago Drainage Canal.

All of which is respectfully submitted.

O. H. ERNST,

Brigadier General, U. S. Army, Retired, Chairman American Section.

George Clinton,
E. E. Haskell,
Members American Section.
Geo. C. Gibbons.
Chairman Canadian Section.
W. F. King,

Louis Coste, Members Canadian Section.

Attest:

W. EDWARD WILSON,

Secretary American Section.

THOMAS COTE,

Secretary Canadian Section."

International Waterways Commission progress report, Senate Doc. 959, 62d Congress, 3d Session, pages 67-77.

INTERNATIONAL WATERWAYS COMMISSION.

Message from the President of the United States, Transmitting the Final Report of the International Waterways Commission upon the Proposed Dam at the Outlet of Lake Erie.

Senate Dec. 118, 63rd Congress, 1st Session, pp. 1-15. June 27, 1913.—Read, referred to the Committee on Foreign Relations, and ordered to be printed.

July 2, 1913.—Illustrations ordered printed.

"To the Senate and House of Representatives:

Pursuant to the provisions of an item contained in the river and harbor act of 1902, and subsequent amendments, providing for the formation of an International Waterways Commission and defining its duties, I have the honor to transmit herewith the final report of said commission upon the proposed dam at the outlet of Lake Erie.

Should Congress make provision for the printing of such report as a document, the American section of the

commission requests that 500 copies thereof be made available for its use.

WOODROW WILSON.

The White House, June 27, 1913.

International Waterways Commission, Office of American Section,

Buffalo, N. Y., June 20, 1913. The honorable Secretary of War of the United States:

The honorable Minister of Public Works of Canada:

1. The act of the Congress of the United States which requested that the Government of Great Britain be invited to join in the formation of the International Waterways Commission defined one of the duties of that com-

mission as follows:

The said commissioners shall report upon the advisability of locating a dam at the outlet of Lake Erie, with a view to determining whether such dam will benefit navigation, and if such structure is deemed advisable, shall make recommendations to their respective Governments looking to an agreement or treaty which shall provide for the construction of the same, and they shall make an estimate of

the probable cost thereof.

2. It so happens that the term 'dam' may apply to various works of which the character and object are very different. At the time of passing the act Congress had under consideration the report of the board of engineers upon deep waterways between the Great Lakes and Atlantic tidewaters, dated June 30, 1900, in which it was recommended that the level of Lake Erie be 'regulated'— that is, that its oscillations be reduced—by means of a dam consisting of a submerged weir and of a set of sluice gates placed at its outlet near the head of the Niagara River. The object of these works would have been to raise the low-water surface of the lake without raising the high water, thus completely regulating its level.

It seems probable that this was the kind of works which Congress had in mind when using the term 'dam.' But the term 'dam' may also be applied to a submerged weir without sluice gates, the object of which would be to raise the level of the lake at low water as well as at high water almost to an equal amount, though in the study of the question it was found possible to give the dam a

form which will accomplish a partial regulation.

To distinguish works of this latter kind from those designed to 'regulate' the lake, they may be called 'compensating works.' Thus, the subject has two branches—one, the complete regulation of Lake Erie, and the other, the raising of its level without complete regulation.

3. Naturally, consideration of the complete regulation of the lake was taken up first. It was the subject of our report, dated January 8, 1910, which was printed and distributed by this commission, and was also published by the United States Government as House Document No. 779, Sixty-first Congress, second session. A few of the statements made, as well as the conclusions reached,

in that report will bear repetition here.

4. The Great Lakes, with their connecting channels, constitute the most important system of inland navigation in the world. The traffic which passed through Detroit River, its busiest link, in 1910 amounted to 73,526,602 tons, valued at about \$771,000,000. About 80 per cent. of this traffic is carried in large freight carriers, which are loaded down to the greatest draft that can be carried into the harbors or through the channels between the Lakes, but could be loaded much deeper if the depth of water permitted. Some of the larger of these vessels carry an additional load of 85 tons for each inch of additional draft. Every inch added to the available depth of water would

therefore be of material benefit to commerce.

The Great Lakes constitute a series of enormous natural reservoirs, each of which serves to regulate the flow in the river constituting its outlet and to maintain the lake below. They are interdependent. The study of one, to be complete, must include the study of all. The total area drained by them is about 287,688 square miles. an area considerably larger than the German Empire. Of this total, about one-third is occupied by the lakes themselves-that is, devoted to reservoir purposes. The result is a uniformity of level and a uniformity of flow which are truly wonderful—a perfection of regulation which no work of man ever did or ever will approach. The question propounded was. 'Can the degree of regulation provided by nature be improved?' Enormous forces were to be dealt with, and the results were to be measured in inches. The subject was, therefore, as difficult as it was important.

6. Soon after the organization of the commission a committee of two of its engineer members was appointed

to collect all of the available data and to make an hydraulic analysis of the general regulation of all the lakes. existing records of water-level observations and discharge measurements made since 1860 were collected, analyzed. After a careful consideration of tabulated and studied. all the data, the commission found that only a very moderate degree of improvement in regulation over what nature provides is practicable in any of the lakes, and that, such as it is, this improvement is obtained at the expense and to the injury of the channels below. In the case of Lake Erie it would be possible to raise the extreme low-water stage about 1 foot, and this in turn would raise the low-water stages of Lake St. Clair about 0.61 foot and of Lake Huron-Michigan about 0.27 foot, all without appreciable increase in the extreme high stages. But in doing this the low-water stage of Lake Ontario would be lowered about 41 inches, the available depth in the St. Lawrence Canals would be diminished about 74 inches, and the City of Buffalo would suffer by increased damage from floods and by a postponement of the date of opening navigation in the spring. The question of damage to vested rights was thus introduced. While the advantages of regulation might outweigh the disadvantages if the persons who were to benefit from the former were identical with those who were to suffer from the latter, the difference was not great enough to justify the two Governments in entering upon the vexatious ques-The commission therefore recomtion of damages. mended that the 'regulation' of Lake Erie be not undertaken, meaning thereby the most complete practicable regulation such as can be secured by a dam and sluice gates located at or near Buffalo.

7. The second branch of the subject committed to us, or works to raise the level of Lake Erie with partial but not complete regulation, which we have called 'compensating' works, is the subject of this report. Appended here to is the report of the committee specially charged with

the investigation.

8. As was stated in our former report, the Niagara River at its extreme upper end is an important safety valve for the protection of Buffalo from the effect of storms, and should not be obstructed by a dam, but it seemed possible that somewhere in the river, between Lake Erie and the Falls, a submerged dam might be placed which would greatly benefit the navigation of the

waters above without injury to those below and with only minor damages, if any, to the adjoining lands. To determine this question it was necessary to make a complete survey of the Niagara River from Lake Erie to the falls, including the topography of the adjoining lands. This survey was made by the commission. A survey was made also by the Canadian Government of the Welland River, in Canada, which enters the Niagara about a mile above the rapids approaching the falls. A sketch upon a reduced scale, showing the Niagara River in outline,

is appended. (Pl. I.)

From a study of the maps it appears that the best site for a submerged dam, or weir, is just above the Welland River, extending from Hog Island, at the mouth of that river, to the mouth of Gill Creek, on the American side, as shown on Plate II. As the Welland is a navigable stream, there would be some advantage in placing the weir below its mouth, but the survey of that river showed that a moderate increase in the height of its surface would submerge a considerable area of valuable land. To provide for the navigation of the Welland it is necessary to construct a lock at the Canadian end of the weir. The object of placing the weir as near as possible to the foot of navigation is to improve all of the navigable portion of the Niagara River above. A study of the topography on both sides of the Niagara River showed that the water surface at mean stage could be raised as much as 3 feet at the site of the weir without inflicting damage upon adjacent lands, except for a distance of about 14 miles immediately above the weir on the American side. this place it is proposed to construct a levee of suitable height to protect the land from overflow.

10. The form to be given the weir has been the subject of careful investigation. In order to disturb as little as practicable the natural distribution of flow through the different parts of the cross section of the river, the crest of the weir is broken into four sections, as shown on Plate VI, the height given to each section being such as will raise the surface of the water in that

section 3 feet at mean stage.

11. A cross section of the weir is shown in figure 1, Plate V. This form was adopted after experiment with various types of wair made under as nearly as possible true river conditions. The experiments were made at the hydraulic laboratory of the college of civil engineer-

ing at Cornell University, which was generously placed at the disposal of the commission for the purpose by the authorities of the university. They are described in the report of the committee, hereto appended. The type of weir desired is one which shall be very efficient at high stages of the river, and much less so at low stages. The form adopted fulfills these conditions, though it is quite possible that a still better form may be developed

with further experiment.

12. The effects of the weir upon the Niagara River at different places and upon Lake Erie at low, mean, and flood stages are shown upon Plates III and IV, the former through the Tonawanda Channel and the latter through The plates show the natural the Chippewa Channel. surfaces at these three stages, and also the backwater surfaces caused by the weir as computed by Bernouilli's theorem for steady flow. The effects are also given in Table No. 1. It appears from this table that the level of Lake Erie will be raised 0.51 foot at extreme low stage, 0.39 foot at mean stage, and 0.11 foot at extreme flood At low water the surface of the Niagara River will be raised 1.08 feet at the Buffalo waterworks; 1.66 feet at Strawberry Island, about 51 miles from the lake; 2.14 feet at Black Creek, about 11 miles from the lake; 2.99 feet at La Salle Landing, about 18 miles from the lake; and 3.05 feet at Schlosser's Dock, the foot of naviga-At flood stage these numbers are: For Buffalo waterworks, 0.19 foot; for Strawberry Island, 0.42 foot; for Black Creek, 0.59 foot; for La Salle Landing, 0.82 foot; and for Schlosser's Dock, 0.91 foot.

13. The effect of raising the mean level of Lake Eric 0.39 foot would be to raise the mean level of Lake St. Clair about 0.23 foot; and the mean level of Lake Huron

about 0.09 foot.

14. To change the level of a great inland sea like Lake Erie, upon the shores of which are many populous cities, is a matter to be approached with caution. Any important increase in the height of the high-water level may cause serious damage to the wharves and low-lying lands. Care must be taken to avoid injury to vested rights. In this case, the ordinary high-water level is increased only 0.38 foot, or 4½ inches, and the extreme flood stage at Buffalo is increased only 0.11 foot, or 1½ inches.

15. The construction of the weir recommended in this report will affect to some extent the levels in the first

reach of the Barge Canal from Tonawanda to Lockport. The level of the Niagara River at Tonawanda would be raised by 1.71 feet at mean stage, and by 0.55 foot at flood stage, so that inasmuch as no provision has been made at the entrance of the canal against the rise which the construction of the weir will cause, it is in our opinion necessary to provide for the construction of a guard lock, the cost of which is included in our general estimate.

16. It is our opinion that the capacity of the lock to enter the Welland River is a domestic question to be decided by the Canadian Government. We have introduced an item of \$500,000 in the estimates to provide for the construction of that lock, but its dimensions should conform to the capacity which the Canadian Government shall determine to give to the connecting waterways, and this estimate can be regarded only as a rough approximation.

17. The weir is to be constructed of concrete and its

cost is estimated as follows:

Rock excavation, 36,300 cubic yards, at	A145 000
\$4 per yard	\$145,200
Concrete, superstructure, 44,000 cubic yards, at \$12 per yard	528,000
Concrete, substructure, 48,500 cubic yards, at \$10 per yard	485,000
Cofferdam, 105,500 cubic yards, at	200 050
\$3.50 per yard	369,250
Pumping and maintenance, lump sum	210,000
Lock into Welland River	500,000
Guard lock at Tonawanda	500,000
Excavation for retaining walls along Niagara River, 16,000 cubic yards, at	
\$3 per yard	48,000
cubic yards, at \$10	125,000
	2,910,450
Add for engineering and contingencies about 20 per cent	589,550

 it would eliminate the possibility of the power companies at the Falls having any injurious effect upon the level of Lake Erie. The Niagara River below the weir and the conditions upon Lake Ontario and the St. Lawrence River would remain without appreciable change. The weir has small regulating effect upon the levels of Lake Erie, the range of the oscillations of the lake being reduced about 4½ per cent. The average natural low stage, 571.3, is raised 0.45 foot, and the average natural high stage is raised 0.38 foot, a difference of 0.07 foot. The storage in Lake Erie is reduced only by that amount, which is not sufficient to affect the level of Lake Ontario seriously.

19. It is possible that the Canadian Government may prefer to assume the damages from overflow in the valley of the Welland River, which would be caused by placing the Canadian end of the proposed weir below the mouth of the Welland, and thus make the lock unnecessary. If so, provision for this should be made in any treaty.

20. The commission believes that the very great advantages to navigation interests will justify and amply repay the necessary expenditure, and we recommend that a treaty be entered into between Great Britain and the United States providing for the construction of the weir.

O. H. Ernst,
Brigadier General U. S. Army, Retired,
Chairman American Section.
George Clinton,
Member American Section.

E. E. HASKELL, Member American Section.

Attest:

W. Edward Wilson,
Secretary American Section.
Geo. C. Gibbons,
Chairman Canadian Section.
Louis Coste,
Member Canadian Section.
Wm. J. Stewart,
Member Canadian Section.

Attest:

THOMAS BOTE, Secretary Canadian Section. TORONTO, ONTARIO, December 13, 1912.

The International Waterways Commission:

Your committee, which was appointed to investigate the advisability of locating a dam at the outlet of Lake Erie and the maintenance and regulation of suitable levels on the other lakes in the Great Lakes system, closed its report of December 4, 1909, upon this subject with the following paragraph:

'Your committee had hoped to present a discussion of a project for compensating Lake Erie for the loss of level due to diversions by works placed above the rapids approaching Niagara Falls. A preliminary examination, however, revealed a lack of data which prevents consideration of the question at this time.'

Your committee now has the honor to submit a report upon this question, thereby completing the duties assigned it.

It may be well at this point to quote a part of the act of the Congress of the United States approved June 13, 1902, to more clearly understand this report:

That the President of the United States 'SEC. 4. is hereby requested to invite the Government of Great Britain to join in the formation of an international commission, to be composed of three members from the United States and three who shall represent the interests of the Dominion of Canada, whose duty it shall be to investigate and report upon the conditions and uses of the waters adjacent to the boundary lines between the United States and Canada, including all of the waters of the Lakes and rivers whose natural outlet is by the River Saint Lawrence to the Atlantic Ocean; also, upon the maintenance and regulation of suitable levels; and, also, upon the effect upon the shores of these waters and the structures thereon, and upon the interests of navigation, by reason of the diversion of these waters from or change in their natural flow; and, further, to report upon the necessary measures to regulate such diversion, and to make such recommendations for improvements and regulations as shall best subserve the interests of navigation in said waters. The said commissioners shall report upon the advisability of locating a dam at the outlet of Lake Erie, with a view to determining whether such dam will benefit navigation; and if such structure is deemed advisable, shall make recommendations to their respective governments looking to an agreement or treaty which shall provide for the construction of the same, and they shall make an estimate of the probable cost thereof.'

Niagara River is the outlet of Lake Erie and discharges into Lake Ontario; it is divided into two reaches by the Falls, the 'upper' and the 'lower.' The upper reach is navigable from Lake Erie to Chippewa, Ontario, and to Niagara Falls, N. Y., and is the reach with which we are Strawberry and Grand Islands at present concerned. divide a part of this reach into two channels, known as Tonawanda and Chippewa. The distance from Lake Erie to the head of Strawberry Island is approximately 4 miles and the fall in this distance at mean stage is 5.8 feet. The distance from the head of Strawberry Island to the end of navigation by the Tonawanda Channel is 161 miles, and between the same points by the Chippewa Channel is The fall in these reaches at mean stage is 4.8 124 miles.

The natural conditions in this upper reach of river are therefore such as to indicate that by placing a submerged weir of proper size at the end of navigation, or below Navy and Connors Islands, it might be possible to create sufficient backwater to restore to Lake Erie a part, at least, of what it has lost in stage by diversions, and at the same time greatly improve the navigation of the reach of river

under consideration.

It was this project that your committee had in mind when it closed its report on December 4, 1909. Naturally, the question arises: Can the water be raised sufficiently at the location indicated to actually restore to Lake Erie a quantity worth while and at the same time keep within control all flood waters, particularly those that come from heavy southwest windstorms on Lake Erie?

To answer this question it was necessary to have more data than existed at the time of our previous report. A careful topographic survey was required of all lands likely to be affected and a type of weir best suited for the loca-

tion and conditions had to be determined.

Surveys were started early in 1910 and prosecuted as diligently as the affairs of the commission would permit. The results from these did not become available, however, until about the beginning of the present year. A detailed topographic survey was made of the shores of the Niagara from Lake Erie to within a mile of the Falls; the islands within this reach, and of the Welland River from its

mouth to its source, a distance of about 40 miles.

In order to determine the best type of weir, it was deemed necessary to study various types under as nearly as possible true river conditions. These studies were made at the hydraulic laboratory of the college of civil engineering of Cornell University, the use of which was generously offered for this purpose. They covered experiments on seven different types, ranging in height from 3.7 to 6.02 feet and having in general a 3 to 1 upstream slope and a 1 to 1 downstream, five having a flat crest and the remainder a rounded crest. In two of the flat-top types, the upstream, and in all the downstream corners were rounded on a radius of 9.5 feet. On two of the flat-top and all of the round-top types, the downstream nappe was an ogee curve.

These experiments were conducted by Mr. E. E. Haslam, assistant engineer to the commission, and the results, which are given more in detail presently in this report, furnish what was being sought—namely, a type of submergd weir that would be very efficient at high stages

and much less so at low stages.

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Fortified with these new data, a study was made of the probable effect of submerged weirs placed at right angles to the general direction of the river in the following localities: Willow Island, Port Day, Grass Island and Gill Island, as well as one on a line between Gill Creek and Hog Island, at the mouth of Welland River, all as shown on Plate II. Only the last of these met the conditions desired, and it is not thought necessary to give the results of the studies of the rejected location because the end to be attained is clearly set forth in the consideration of the site finally chosen.

As shown in our previous report, the stage of water in several of the Great Lakes will be materially lowered ! y artificial diversions of water therefrom. This loss of level on Lake Michigan-Huron, if 10,000 c. f. s. be taken through the Chicago Drainage Canal, will for mean stage

amount to $\frac{10,000}{18,900}$ = 0.53 foot, while the loss of level to

Lake Erie due to this diversion and 1,000 c. f. s. through

the Erie Canal and 1,100 c. f. s. through the Wellant Canal will at mean stage amount 10,000 2,100 = 0.09 foot, respectively, a -=0.43 foot and -23,400 23,400

total of 0.52 foot. The American power companies have also lowered the level of Lake Erie probably by 0.08 foot.

The project here proposed for restoring the loss caused by these diversions is the construction of a submerged weir of suitable type, on a line between Gill Creek and Welland River, as shown on Plates I and II, of such a height of crest as will create sufficient backwater to of-

set it.

To determine this, backwater curves have been computed, based upon Bernoulli's theorem for steady flow. and these are shown on Plates III and IV, the former being for the Tonawanda and the latter for the Chippewa Channel. These plates and Table I show the natural stages of upper Niagara River for low, mean, and flood conditions and also the compensated stages and backwater curves for 3-foot backwater at mean stage, at the proposed Gill Greek-Welland River weir.

The backwater on Lake Erie caused by the submerged weir has also been computed by the supply, storage, and discharge method described on pages 53 and 54 of the commission's report upon the regulation of Lake Erie, dated January 8, 1910, and the results by the two methods check very satisfactorily, the latter giving 0.07 foot greater backwater in the high-water year of 1876 and

0.08 foot greater in the low-water year of 1895.

Owing to the fact that the weir has an increasing efficiency with increase in stage, it was thought that the flow of the river might vary slightly from present natural conditions and therefore might affect injuriously the stage of water in the St. Lawrence Canals. The computed results show that the effect on Lake Ontario of any variation in the flow from Lake Erie caused by the submerged weir would be negligible. See Tables II and III, the former for effect on Lake Erie, and the latter for effect on Lake Ontario.

The type of weir chosen, as best meeting requirements, is shown in cross section on Plate V, Figure I. longitudinal profile of its crest is shown on Plate VI, where it will be seen that it has been divided into four sections, and the weir crest for each section set at such an elevation that it will produce 3-foot backwater at mean stage with the same distribution of flow of water across the river under compensated conditions as under natural

conditions.

This 3-foot rise in mean stage at the proposed weir would raise the level of Lake Erie by 0.51 foot at low stage (570); by 0.39 foot at mean stage (572.6); and by 0.11 foot at flood stage (579.18). The increased stage of Lake Erie would decrease the slope in Detroit River and would cause Lake St. Clair to rise until the discharge through that river had a value equal to the present discharge under natural conditions. When this condition occurred Lake St. Clair would have risen in level by about 0.23 foot at mean stage. Likewise, the increased stage of Lake St. Clair would in turn decrease the slope in St. Clair River and Lake Huron-Michigan would rise until the slope became such as to produce a discharge in St. Clair River equal to its present discharge under natural conditions. This increased stage in Lake Huron-Michigan, corresponding to 572.6, mean level of Lake Erie, would be about 0.09 foot.

The discharge of the Niagara, corresponding to mean level of Lake Erie of 572.6 (see report on regulation of Lake Erie) and fall of 5.12 feet Lake Erie to Austin Street, Buffalo, is 209,100 c. f. s.; the low-water discharge for stage 570, and fall of 4.52 feet Lake Erie to Austin Street is 153,200 c. f. s.; and the flood discharge for stage 579.18 and fall of 6.42 feet Lake Erie to Austin Street is 376,700 c. f. s. It is this flood with which we are particularly concerned. By reference to Plates III, IV, and VI and Table I it will be seen that this compensated flood stage at the proposed weir would be 1.2 feet higher than the present natural flood stage at this point. The compensated flood stage at Tonawanda Island would be raised 0.55 foot above the present natural flood stage

at this point.

Knowing the elevation of the flood waters of this new compensated flood stage from Lake Erie to the site of the proposed weir, the topographic surveys previously referred to were studied with a view to determining the effect that these new flood waters might have upon adjacent lands. So far as can be seen, but little, if any, damage would result from the proposed weir placed on the

Gill Creek-Welland River section. Our investigation has also shown that it would not be possible to raise the water at the weir by much more than 3 feet without danger of damage from floods.

It should be here stated that it was found impracticable to place this weir below the mouth of Welland River because of the large land areas that would be affected along

this stream by increased stage of flood waters.

As Welland River is navigable and as there is a connection between the Welland Canal and the Niagara by this stream, it would be necessary to provide a lock at the Canadian end of the weir, as shown on Plate II.

The construction of the weir recommended in this report will affect to some extent the levels in the first reach of the Barge Canal, from Tonawanda to Lockport. The level of the Niagara River at Tonawanda would be raised by 1.71 feet at mean stage, and by 0.55 foot at flood stage, so that inasmuch as no provision has been made at the entrance of the canal against the rise which the construction of the weir will cause, it is in our opinion necessary to provide for the construction of a guard lock, the cost of which is included in our general estimate.

Having discussed the various engineering features of this project, we may now set forth the advantages that would result. First among these is the restoration to Lake Erie of 0.39 foot to its mean level. It is difficult to estimate this in money value, but it certainly would be many times the cost of the weir, in betterment of Lake Erie harbors and conditions at the mouth of Detroit

River.

Secondly, it would greatly improve the navigation of the upper Niagara and thereby greatly benefit a locality which must sooner or later become a harbor or shipping

port for important industries.

Thirdly, it would eliminate the possibility of the power companies at Niagara Falls having any injurious effect upon the stage of water in Lake Erie. The river below the weir would remain unchanged.

Fourthly, conditions on Lake Ontario and St. Lawrence

River would remain unmolested.

Lastly, a bridge could be made a part of this weir, which would provide a free highway from one country to the other, open to the citizens of both.

Estimate of Cost of Proposed Weir.

Rock excavation, 36,300 cubic yards, at \$4 per	
vard	\$145,200
yard	
\$12 per yard	528,000
Concrete, substructure, 48,500 cubic yards, at \$10	
per yard	485,000
Cofferdam, 105,500 cubic yards, at \$3.50 per yard	369,250
Pumping and maintenance, lump sum	210,000
Lock into Welland River	500,000
Guard lock at Tonawanda	500,000
Excavation for retaining walls along Niagara	
River, 16,000 cubic yards, at \$3 per yard	48,000
Concrete for retaining walls, 12,500 cubic yards,	
at \$10 per yard	125,000
	2,910,450
Add for engineering and contingencies 20 per cent.	582,090
Total	3,492,540

SUBMERGED-WEIR EXPERIMENTS.

As previously stated in this report, submerged-weir experiments were made upon seven different types of weirs, ranging in height from 3.70 to 6.02 feet. All of the models were approximately 4 feet long. The following table, No. 4, gives the dimensions of the several models tested:

TABLE No. 4 .- Dimensions of submerged-weir models.

Model No.	Length.	Height.	Crest.	Width bot- tom.	Upetream face.	Down- stream face.	Remarks.
1	Feet. 4.005	Feet. 6.02	Flat, 6 feet wide	Feet. 31.76	1-3 slope	1-1 slope	Upstream corner sharp, downstream conies rounded, radius 9.5 feet.
	4.01	4.53	do	35.79	do	do	Do.
	4.01	4.53	do	27.33	do	do	Up and down stream eor- ners rounded, radius 9.5 feet.
4	4.02	8.17	Rounded, radius	27.70	do	do	Ogee curve downstream
	4.006	4.85	do	23. 50	do	do	Ogee ourve bottom, down
•	4.005	3.70	Fiat, 6 feet wide	23. 80	do	do	Upstream corner sharp downstream corner rounded, radius, 9.5 feel Ogsecurve bettom do wa stream face.
,	4.008	2.70	do	25.04	do	do	Up and down stream cor- ners rounded, radius 9.1 feet. Oges curve bottom downstream face.

These models were placed in a wooden flume 95.5 feet long, 10 feet high, and 4 feet wide, constructed in the open concrete canal of the hydraulic laboratory at Cornell University, Ithaca, N. Y. The dimensions of the canal are 418 feet long, 16 feet wide, and 10 feet deep. The grade of bottom of channel is approximately 1 foot in 500. A bulkhead located about 60 feet from upper end of canal divides it into two parts. A standard sharp-crested weir placed on top of this bulkhead measures the quantity of water flowing in canal. The wooden flume mentioned above was built in this canal, the upper end being located about 87 feet below the standard weir. upper end of flume had a bell-shaped mouth, about 15 feet long, converging from 16 feet, the width of canal, to 4 feet, the width of flume. The crest of weir of tested models was placed about 46 feet below upper entrance to bell mouth. The flow of water over the standard weir, through the canal, and over the experimental models was regulated by gates at the head and foot of canal. By the manipulation of these gates various discharges, submergences, and heads on the experimental weir models were secured. The upstream head was measured in the flume with a plumb-bob attached to steel tape at a point about 25.5 feet above the upstream edge of crest of flat weir, while the downstream head was measured in the same way in still water behind the flume on both sides and about 16.6 feet downstream from the upstream edge of crest of flat weir. The longitudinal water surface curve over the weir was determined for all models under various conditions

of flow. The flow of water over these experimental models varied between 27.6 and 203.2 second-feet, equivalent to 6.87 and 50.75 c. f. s. per linear foot of weir, respectively. The upstream heads on the weir varied between 1.66 and 6.35 feet and the ratio of submergences between 0 and 95. The experimental coefficients as derived are based upon the submerged

weir formula $D=cF^{\frac{1}{2}}(H+-)$, where D=discharge per linear

foot of crest, H=upstream head, d=downstream head, F= fall or upstream head minus downstream head, c-experimental coefficient. The weir coefficients for the flat-crest models are given in Table 5 and are shown on Plate V.

TABLE No. 5 .- Weir coefficients, flat-top model.

Weir condition.	Average minimum river flow per linear foot of weir.	Coefficient.	Average mean river flow per linear foot of weir.	Coefficient.	Average maximum river flow per linear foot of weir.	Coefficient,
Pres. 0.1 submergence. 0.2 submergence. 0.3 submergence. 0.3 submergence. 0.4 submergence. 0.5 submergence. 0.5 submergence. 0.5 submergence. 0.5 submergence. 0.5 submergence. 0.7 submergence. 0.8 submergence. 0.9 submergence. 0.9 submergence. 0.9 submergence.	C. f. s. 18. 00 18. 00 18. 00 18. 00 18. 00 18. 00 18. 00 18. 00 18. 00	3, 120 3, 145 3, 195 3, 200 3, 340 3, 730 4, 125 4, 850 5, 930	C. f. s. 25. 00 25. 00 25. 00 25. 00 25. 00 25. 00 25. 00 25. 00 25. 00	3. 160 3. 190 3. 245 3. 306 3. 397 3. 540 3. 750 4. 190 4. 910 8. 025	C. f. s. 48. 00 45. 00 45. 00 45. 00 45. 00 45. 00 45. 00 45. 00	3. 260 3. 300 3. 343 3. 419 3. 800 3. 685 3. 900 4. 330 5. 060 6. 210

The weir coefficients of the rounded-crest models were about 5 per cent greater than those of flat-crest models, but the coefficient increment was about the same for each type within the limits for river conditions. The flat-crest model was therefore adopted on account of the easier construction, inspection, and repair.

Plate VII is a diagram of submerged-weir coefficients for the flat-top model shown in Fig. I, on Plate V, based upon and derived from the experiments hereto described and made at the Cornell University hydraulic laboratory, Ithaca, N. Y., in

November and December, 1911.

Your committee do not wish it understood that the type of weir here proposed is the most desirable one for the purpose. The experiments made were by no means sufficient to settle this question. It is very probable that further experiments would reveal a still better type. The one proposed does demonstrate, however, that the project is feasible.

E. E. HASKELL,

Member American Section.

WM. J. STEWART,

Member Canadian Section.

Attest:

W. Edward Wilson, C. E., Secretary American Section.

TABLE NO. 1.—Natural and compensated stages and backwater curves of Nagara River between Niagara Falls and Lake Brie.

Magnes River sections.	Distance from Buffalo light.	THE STATE OF THE S	1	Backwater at mean stage.	Natural low stage.	Company of the Park	Post of the second seco	Natural flored stage.	Compete- sated flood stage.	
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d Fork Erie, opposite ange dura landa fist or Forks. Sistrocks.	333	223	588	1975	8.58	222	288	875.88 8.88 8.88	576.98 575.58	
	1,4 86	2 S	33	22				26	57.2	
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onswunds Island. s. Selbe Lending	, 8 8 8 8 8 8	201.10		121				3	808.30	4
Objects Dock: Va Transmida Chambel. Via Chitypewa Chambel.	88,700	360.83	208.28	2.51	862.20	265.34	3.06	547.70	208.01	=
III Overk-Welland Bilver Wise section: Vis Tomewands Chemis Vis Chippeer Chemis	112,800	1 362.96	366.96	8.00	1.861.50	866.11	3.61	556.55	887.75	1.8
ress Island: Via Tonawanda Chamel. Via Chippewa Chamel.	114,300	. WIL 86	861.98	•	360.62	560.62	0	265.06	865.68	
Via Chippewa Channel.	119,100	560.30	200.20	0	550.30	550.30	0	562.68	562.68	

Not observed gauge readings; obtained by interpolation.

INTERNATIONAL WATERWAYS COMMISSION.

See See		River, 100 c. f. t., mean of month.		25828°85838 +++++++	1++++++11+1
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Table No. 3.—Bfeet of compensation of Lake Brie on water levels of Lake Ontwio in high-water year 1876 and low-water year 1896.

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EXTRACT FROM REPORT OF CHIEF OF ENGINEERS' REPORT, 1900, APPENDIX III:

"APPENDIX III:

Northern and Northwestern Lakes—Correcting and Issuing Charts—Surveys—Water Levels.

Report of Lieut. Col. G. J. Lydecker, Corps of Engineers, for the Fiscal Year Ending June 30, 1900.

III 1.

United States Engineer Office,

Detroit, Mich., August 15, 1900.

General: I have the honor to submit herewith my annual report on survey of the Northern and Northwestern Lakes for the fiscal year ending June 30, 1900.

Very respectfully, your obedient servant,

G. J. LYDECKER, Lieut. Col., Corps of Engineers.

Brig. Gen. John M. Wilson, Chief of Engineers, U. S. A.

Northern and Northwestern Lakes—Correcting and Issuing Charts—Surveys—Water Levels.

The survey of the lakes as a connected and systematic work was commenced in 1841 and completed in 1882, but local surveys by officers of engineers for special purposes, including harbor improvements, date back to 1817. After the general survey was completed, in 1882, operations were limited to the publication and issue of the Lake Survey Charts until 1889, under annual appropriations of two or three thousand dollars, but from the last-mentioned date additional appropriations, varying from five to

twenty-five thousand dollars, were made annually for surveys relating to additions to and corrections of the original charts. In 1898 these operations were extended to include observations and investigations of lake levels, with a view to ascertaining the causes of changes in level, determining the hydraulic data needed for formulating the laws of interlake flow, and devising the most feasible method of lake level maintenance or regulation."

Chief of Engineers Report, 1900, App. III, page 5317.

EXTRACT FROM REPORT OF CHIEF OF ENGINEERS, 1900, APPENDIX III, BEING REPORT OF ASST. ENGINEER F. C. SHENEHON, DATED BUFFALO, JULY 18, 1900:

"The Niagara River, as it breaks out of Lake Erie, flows almost due north. It narrows rapidly and passes swiftly through a choken section of limestone, where the speed at mid-river must approximate 8 miles an hour. Emerging from this, the river grows wider and deeper and slows up to about 5 miles an hour as it approaches the International Railway Bridge, 12,000 feet below the head of the river.

In this distance the fall is about 5 feet at mean lake

stage.

The bridge consists of nine spans on masonry piers carrying a single-track railway. Enough clearance exists between the track and the through trusses for footways on each side, which are, however, cramped and not open to public travel. The base of rail is about 24 feet above the water surface. The piers rest in timber caissons and are provided with cutwaters. Protective masses of large stone are dumped about the piers, making a somewhat ragged profile and a bottom dangerous to instruments.

The piers have a small battir, but may be considered

vertical for river-gauging purposes.

The length in feet of clear waterway and the maximum depth of the several spans are as follows:

Number of span.	Length	Maximum depth.	Percentage of discharge pass- ing each span,
1	151.5	13.1	0.5
2	154.1	13.8	2.5
3	156.2	35.7	9.7
4	234.2	48.3	28.2
5	235.8	47.3	26.7
6		50.7	18.2
7		26.6	8.6
8	184.3	17.1	5.5
9		9.6	0.7

The numbering of the spans as used in the gauging begins on the east end, the drawbridge spanning the second and third openings, the ship channel passing through the third.

The long spans, 4, 5 and 6, naturally divide up into three station lengths of about the same size as the halfspan lengths in which the remaining openings are conceived as divided. This cuts up the clear waterway of the river into 21 station areas, each about 80 feet long. Each of these is divided again into four substations of about 20 feet. Midway of each station area, and at approximately three-tenths depth, a point is taken as representative of the velocities throughout the area. Because it indicates the station discharge it has been called the index.

The measurement of the discharge consisted in obtaining the velocities at each of the 21 station indexes in quick succession. Coefficient work then established the ratio between the mean velocity in the station area and the observed index velocity. With cross-sectional aredetermined by the soundings, the station discharge = coefficient × index velocity × cross-sectional area; and the full-river discharge is a summation for all stations of these partial discharges.

In the open section below the bridge the 1,720 feet between the terminal cribs was divided into 16 stations of 100 feet and 1 of 120 feet; and the indexes were taken at mid-station at approximately four-tenths depth.

Reconnaissance soundings from the bridge were taken by the Board of Engineers on which index depths were founded, and the station scheme as used by them was followed in the Lake Survey work on this section.

The Lake Survey soundings were subsequent to considerable meter work, but as logically soundings should

precede this they will be taken up here.

A current of 5 miles an hour with a depth of nearly 50 feet in the fourth and fifth spans of the bridge rendered ordinary methods of sounding inaccurate. Even as heavy a lead as 40 pounds on a sash cord thrown upstream and quickly dropped to bottom gave results that are indeterminate in two particulars. First, the observer is unable to say whether the lead is on the bottom above, below, or in the plane of the section; second, with the lead touching bottom and dragging a belly is created in the sounding line by the current pressures on it of unknown form, and the indicated depth is too great by an unknown amount. An error of 2 to 3 feet in 50 may readily enter in a 5-mile current from these causes.

A percentage error in the soundings of a station produces the same percentage error in the volume of discharge of that station, since mean depth × width × mean

velocity = discharge.

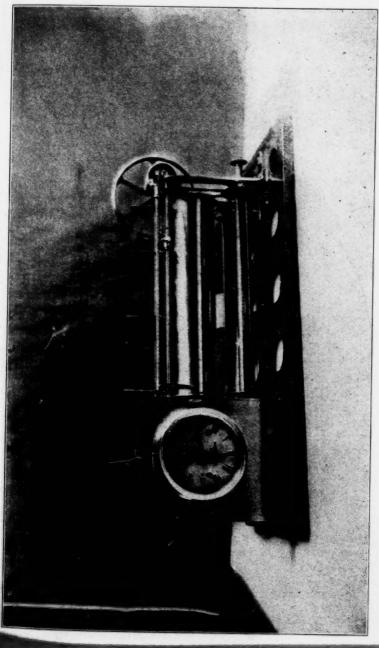
Moreover, it is in the important stations where, with highest speed and greatest depth, the discharge is largest that this percentage error is most likely to occur; and it is in these stations that accurate soundings is most imperative by reason of their weight in the aggregate volume of flow.

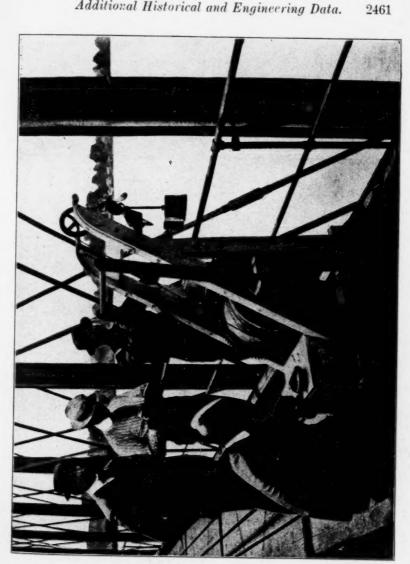
Any refinement in the other factors that enter into the problem of river gauging is annulled by less refinement

in the sounding."

Report of Chief of Engineers, 1900, App. III, pages 5328-5329.

Attached to said report of Francis C. Shenehon are plates 5 and 6 opposite page 5326 of said report, which are inserted opposite hereto in connection with Mr. Shenehon's report.





Further Extract from Report of Francis C. Shenehon, Dated Buffalo, July 18th, 1900:

page 5338.

"An excellent rating of the B meter was made of 67 observations and a very elaborate rating of the A meter

consisting of 173 observations.

This latter was stretched over five days in an attempt to trace the cause of what has appeared elsewhere as a diurnal variation of the rating constants. The several days, however, failed to show any considerable change, and the observations almost deny what is clearly indicated throughout all the two meter work, and what other ratings made by myself and by other observers show to be a fact. This variation of 1 or 2 per cent. on either side of a mean rating line is baffling in the extreme.

Whether it is in the manipulation of the instrument or independent of the slight condition changes that may be controlled by the observer, and in the metallic structure of the bearings or the varying pressures of the contact pin, is yet to be solved. As the mean rating of the instrument was known the mean discharge line will be true in spite of this, but the error of individual observa-

tions has a wider range.

In coefficient work this was eliminated by comparisons of the two meters employed, as their wheels spun side by

side in the river current.

Assuming that the velocity of the current in which the two meters are running is measured by one of them whose rating constants have been established on a still-water base, it is apparent that a series of these simultaneous runs in stations of different velocities constitutes a rating of the second meter.

It is apparent also that any small percentage error existing in the velocities indicated by the first meter will

be present in the second as well.

From this it follows that when one meter is rated by comparison with another the two instruments become a compound instrument, and that when velocities are simultaneously measured by the two wheels the ratio of the two velocities is correct, notwithstanding the percentage error in the absolute velocities, since this is eliminated in the ratio by appearing both in the numerator and denominator.

On this principle the two-meter system depends. It is

slightly in error in practice, since rating variations do not follow strictly percentage lines. But a small error in small quantities may be treated as a differential of the second degree and neglected. Daily ratings were made in the current as a basis for the value of the revolutions of the B wheel.

Coefficient work in river gauging consists in determining velocity ratios of many points in a station area with

respect to some central point.

Discharge observations measured the absolute velocity

at this central point.

It must be emphasized that these two classes of work

furnish two criterions of ratings.

For discharge work the absolute rating is necessary, and this was dependent in the Lake Survey gaugings of this river on still-water calibrations.

For coefficient work, the relative rating is alone required and this was obtained by current comparisons.

This distinction, which is vital, will be made clear by the following parallel:

Revolutions of wheel

per second

Corresponding absolute

velocity 1.35 2.57 3.79 5.01 6.23 Corresponding relative

velocity .270 .513 .756 1.000 1.244 1.485

The relative velocities are here derived from the absolute by dividing through by 5.01, which gives a percentage scale in which the velocity at four revolutions is taken as unity.

In judging the rating used on the meter which measures absolute velocities, the criterion is whether the velocities corresponding to given revolutions are the same as derived by other ratings, and that it is internally consist-

ent.

In passing on the rating used on the meter, measuring ratios, it is enough if the velocity percentages for even revolutions are constant; and two ratings that are widely different in absolute velocities may be in perfect agreement in relative velocities. page 5340.

For the work on Niagara River velocities below 2 feet per second are of very little moment, so little that an error of 5 per cent. in them would not amount to an error of one-tenth of 1 per cent. in the final result of the discharge. For this reason the rating line below this was

ordinarily determined graphically.

The most luminous way found of doing this was by platting the total number of revolutions on the rating base as abscissae, with the velocities per second as ordinates, and sketching in the line of variation of the total revolutions; then solving the corresponding revolutions per second for a number of velocities and interpolating the balance.

When all observations, high and low, were platted in this way, the rating line for high velocities could be drawn in with an accuracy exceeding one-half of 1 per cent.

After solving a straight-line equation for the higher velocities, the residuals (computed minus-observed velocities), were taken out, grouped for velocity intervals, and platted. This method revealed the line of the A meter to be a reversed curve. An examination of the total number of revolutions on the base shows the same tendency for this meter, as the revolutions reach a maximum at 3-foot velocity and fall off for higher or lower speeds.

The B line is parabolic, with little curvature in high

velocities.

These slight curvatures are refinements that need not be emphasized, but were taken into consideration in the reductions.

The velocities derived by curve and straight line formulae are compared in the summary table. See ratings

6 and 7, and 8 and 9 for A meter.

Rating No. 1 for the B meter was used on all discharge measurements taken with this instrument during the sea-

son of 1898 on the bridge section.

Rating No. 5 for the A meter was used for the October-November, 1899, discharges on the open section. The December discharges platted off the line of the previous discharges by using No. 5, but are aligned by using No. 6, which represents the rating of the meter at the close of the season.

For coefficient work on the bridge section the current rating No. 2 of the B meter, which depends on rating No.

5 of the A meter, was used.

The validity of this rating is shown by a comparison with still-water rating No. 3, which immediately followed the coefficient work.

The rating of the B meter used in coefficient work on the open section was No. 6, derived from No. 5 rating of the A meter by 388 side-by-side current comparisons.

That a certain rating was used in coefficient work must be stated, with the reservation that velocity ratios obtained on any day by using two specified ratings of the two meters were corrected by the same percentage as was necessary to apply to the ratios of the meters in the same current to bring them to unity.

From the rating equations, rating tables of absolute velocities were made giving all velocities corresponding to wheel revolutions from 0.00 to 6.00 per second, by 0.01

increments. These were used in discharge work.

For coefficient work, velocity percentage curves were constructed, from which the velocity ratio was taken off directly from the indicated revolutions per second of the

two wheels.

This proved of great service in the vast amount of this work done on the two sections. Each day's work in the river on the open section by the two-meter method gave upward of a hundred velocity ratios to solve in duplicate. Without this graphic method of solution the winter office force of four men would have been overwhelmed by the accumulated mass of observations.

The percentage curves gave results accurate to a fifth of 1 per cent., with no systematic error, and were skill-

fully used by assistants of little office experience.

The correction applied to percentages derived from this curve was indicated by the ratio obtained by speeding the meters side by side. It is evident that the velocity percentage obtained from the curve when the meters run side by side should be 100, but in practice it varied 1 or 2 per cent. on either side of this. This was due to the daily fluctuations of ratings before mentioned, and coefficient work done on each day was corrected for this, as follows: When the mean of the daily current ratings indicated by the curve was 102 per cent., it was assumed that all ratios obtained that day were too large by 2 per cent., and each was therefore divided by 1.02. If the mean daily rating showed 98 per cent., all ratios were increased 2 per cent.

The calibration of the instruments is such an important part of river gauging that considerable space has been devoted to describing the methods used on the Niagara River as precedent to their use in current measurement.

In discharge work on the bridge, the B meter was carried on the same reel, mounted on trucks, that was used in sounding. Each revolution of the drum reeled off exactly 5 feet of the quarter-inch steel cable, by which the meter was suspended. Electric connections between the meter cable on the moving drum and the stationary batteries (which were carried in a box beneath) was maintained by brass springs bearing against concentric brass rings on the head of the drum.

From the drum the cable led up over a pulley on an overhanging arm which swung the meter clear of the hand rail of the bridge, so that it could be dropped between

the eyebars of the lower chord to the water.

With the meter at the index, which was approximately at three-tenths depth at each station, a two-minute run was made. The meter was then wheeled to the next, and to all stations successively, taking a two-minute measurement of the current speed at each. The mean length of current thread measured at stations was about 650 feet in the run of 120 seconds, being more than this in the mid-river spans, and less toward the shore.

The observing party consisted of five men—the observer, the recorder, two men on reel, and one watchman to warn the party of the approach of trains, and to keep a lookout for the drift that might injure the meter.

It took from an hour and a half to two hours to measure

a discharge.

The location of the meter at the index depth was somewhat complicated by the swinging of the instrument downstream by the current, with a resulting inclination of the cable, which was different from each lake stage. By taking the angle that the cable made with the vertical at mean stage for each of the swift-water stations, the amount of cable to reel off after the meter axis was at water service was computed for each.

To this was added algebraically for any other stage

three-tenths of the change in the section gauge.

The precedent of making no correction for the greater inclination of the cable under high velocities, established by the Board of Engineers on Deep Waterways, was followed in the lake-survey discharges.

As the velocity ratio is so nearly constant close above

and below the three-tenths depth, the dipping of the meter a foot or two below the proper index depth in low stages, and rising as much above it in high, which with this amplitude was confined to the deepest, most rapid stations, resulted in no great inaccuracy. This range was much reduced in the winter and spring of 1899 by the use of the 136-pound lead on the B meter instead of the standard 36-pound one.

In coefficient work the A meter was set at the index more closely than in discharge observations, and the B meter, with its great weight, was placed accurately in its proper position in the vertical by corrections that took into consideration the curvature of the cable below water and the inclination above, as detailed in the discussion

on methods of sounding.

Coefficient work was carried on with two meters, the A meter at the index, while the B meter made simultaneous runs, obtaining the velocity ratio directly for as many points in the station area as was judged desirable to es-

tablish the mean velocity ratio.

Coefficient work follows essentially a cross-sectioning process, similar in many respects to earth work measurement. Its object is to find the volume of water at the mean section-gauge height passing a station area when the index velocity is taken as unity. This volume, divided by the cross-sectional area developed by the soundings, gives the mean velocity as a percentage of the index velocity.

This is the velocity coefficient, which reduces the product—the cross-sectional area into the velocity obtained in a discharge measurement—to station volume of flow.

In such a section as that of the international bridge the proper derivation of the velocity coefficients is the

most difficult part of the river gauging.

To obtain it the writhing mass of water streaming through the bridge openings and eddying about the piers, spurting and lagging in minor pulsations, speeding faster as the lake rises and flowing leisurely in low stages, must be congealed to a solid by some instantaneous method of survey, and its dimensions taken.

The two-meter method of work was the instantaneous

process used to attain this result.

With all its variations of velocities a law of flow is followed by which percentage velocities tend to remain constant. If the current threads speed up at the index where the A meter was placed, it quickens proportionally 20 feet away, where the B meter is spinning; so that, with a large range in absolute velocities, so long as the relative position is held, the ratio, B's velocity divided by A's velocity, tends to remain constant.

The abruptly changing conditions of the bottom at the bridge made it necessary to observe velocity percentages from surface to bottom at many substations. This was done on all the regular substations—about 20 feet apart—into which each station was divided, and in addition pluses were put in near the piers, and wherever else the conditions seemed to indicate a possible change.

The following summary shows the number of points at which these vertical curves were measured in each station area:

Summary of Vertical Curves, Bridge Section.

Span.	Index station.	Number of curve stations.	Span,	Index station.	Number of curve stations.
2	. 2	5	5	10	6
2	. 6	5	6	2	6
3	. 2	5	6	6	4
3	. 6	6	6	10	5
4	. 2	7	7	2	7
4	. 6	4	7	6	6
4	. 10	4	8	2	7
5	. 2	7	8	6	6
5	. 6	4			

Curves were taken in spans 1 and 9 at all substations, but were not used, coefficients previously derived being accepted.

A duplicate set of observations was made on each curve. Beginning just below the surface, the B meter was started simultaneously with the A meter (which remained at the index) and both stopped at the end of four minutes. This was repeated at different depths until the B meter reached bottom. The B meter, then observed at the same depths as it was brought upward, obtaining a duplicate set of percentage velocities. As the observations were made, they were reduced and platted on the bridge, and any showing widely different from its original, or off the line traced by the others, was again repeated.

Guys above water were used to hold the B meter from sagging down stream in the strong current. Side-by-side ratings of the two wheels maintained the integrity of the compound meter.

These ratings were ordinarily carried on as follows: The A meter was set at 5 feet depth, well away from the piers; the B meter was set at same depth, abreast, and

about 4 feet west of it.

Two or three 2-minute runs were then made simultaneously, after which the B meter was placed the same distance east of the A and the observations repeated. Observing east and west of the B meter eliminated the effect of the change of velocity along the section.

This current rating was repeated for different veloc-

ities.

Early in the observations the importance of this as a basis of corrections was not fully grasped and the ratings were not always made daily, but enough were made

to give an excellent key for interpolation.

It will be observed that what have been mentioned as vertical curves are, more accurately, vertical-transverse curves, because each point has been referred to the index, which involves the change in velocities latterally as well as vertically, so that the mean ordinate of any of these curves is the vertical-transverse coefficient for the substation which it governs.

The third element that enters into the sub-station co-

efficient is the direction coefficient.

The direction of the current flow was not, as a rule, at right angles to the bridge, but at mid span the trend was 2 or 3 degrees to the eastward, and nearer the piers was deflected from them, so that for each opening the

threads tended to converge in a vena contracta.

The surface indication of the direction was taken as the direction at all depths, and the angle taken by a 20foot line flush with the water surface, to which was attached a weighted float, while the upstream end was attached to the weight of the B meter lowered from the south side of the bridge just below the water, was accepted as a basis for direction coefficient.

This was observed for all substations, and additional

observations were put in around the piers.

The influence of the direction element on the measured discharge is minute, almost negligible.

With the many substations coefficients, transverse, vertical, and direction, which combined make the required velocity coefficient, the proper methods of combining them to arrive at an accurate result is important.

In discussing the methods used to compute the volume of river flow, it will be necessary to derive some equations

that are fundamental in an elementary manner.

This is peculiarly true of those involving the velocity coefficient. As the conditions at the bridge section are such as to call for the observance of accurate methods in the derivation of this ratio, instead of the more simple approximations that may be safely used in an unbroken stream, the detail of the theory on which it was computed is given.

It has been demonstrated in river hydraulics that the velocities throughout a certain area maintain definite percentage relations, and when these relations are firmly established by ample observations, a single known velocity is the key to all others simultaneously existing, and hence

to the discharge in the area involved.

On this characteristic of river flow are based the methods used to determine the volume of water which the river carries in its various stages and conditions. Like most hydraulic laws, this has its limitations, and is more nearly absolute as the area considered approaches an element of river width.

How accurate it is for the full river width is shown by the following tabulation, in which the mean velocities for each station derived from groups of discharge measurements are expressed as percentages of the mean velocity of all stations for the same group.

INDEX VELOCITIES AS PERCENTAGES OF MEAN INDEX VELOCITY. OPEN SECTION TABLE 5.

	GROUP 1	NO. 2	60	4		9	Total	Weighted
Number of observations in group. Elevation of lake gauge. Mean index velocity.	10 572.0 4.84	10 571.4 4.58	10 571.2 4.51	10 571.1 4.45	10 570.9 4.38	7 570.5 4.21	19	571.2 4.51
T	42.6	33.9	28.4	23.5	25.6	20.2		30.6
6	81.3	0.62	78.6	77.6	77.3	77.2		78.5
60	626	8.96	7.78	2.66	98.8	97.6		97.8
*	104.5	105.1	105.4	106.0	106.7	106.2		105.6
	126.6	127.8	129.3	127.9	128.1	126.6		127.8
9	129.2	130.5	133.1	133.0	134.4	136.1		132.5
	124.1	125.1	126.1	128.4	125.6	125.7		125.5
20	121.3	122.9	124.6	124.9	124.5	123.3		123.6
	118.2	121.1	120.5	121.4	121.6	122.1		120.7
10	108.9	110.5	110.3	110.4	110.7	112.4		110.4
II	107.7	110.6	110.7	111.9	110.8	110.2		110.3
12.	106.7	107.6	106.9	108.6	108.3	109.5		107.8
13.	92.6	93.5	91.9	92.7	91.2	91.9		92.3
14	100.0	8.06	99.3	6.66	101.0	88.8		6.66
15	92.4	6.06	91.3	\$00.4	91.8	90.7		91.3
16	84.1	84.3	84.6	84.2	83.7	83.1		84.0
17	64.1	64.9	61.4	62.1	61.0	6.69		61.8

No serious error will enter from the proposition of fixed relations within the area limited by a proper station width.

It is apparent, however, that velocities will maintain their relation the more accurately as they are closer together, and for this reason the point which is selected as the key to a station discharge should be centrally located in its area. This consideration would point out the center of figure as the desirable location, but a modification of this grows out of the fact that it is more important to know accurately the velocity ratios of the high speeds where the greatest discharge occurs than those of the low. It would therefore seem that the center of gravity of the solid figure in which a second's discharge may be conceived to congeal is the proper location of this point.

As has been stated before, since the velocity here is taken as indicative of the station discharge, this point

has been called the index.

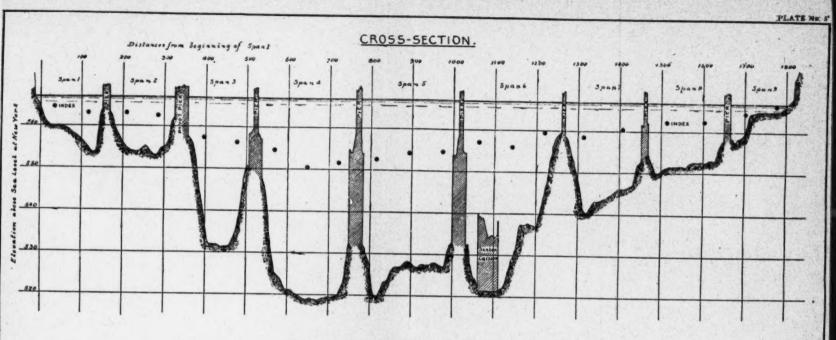
Other practical considerations generally prevail to put the index at mid-station and at a lesser depth than the gravity center. In the bridge section it was taken at three-tenths depth and in the open section at four-tenths depth. The center of gravity would fix it between fourtenths and mid-depth.

For gauging purposes the river width having been divided into N stations of such size that the index in each will accurately reflect changes throughout, the discharge of the river must be the summation of the par-

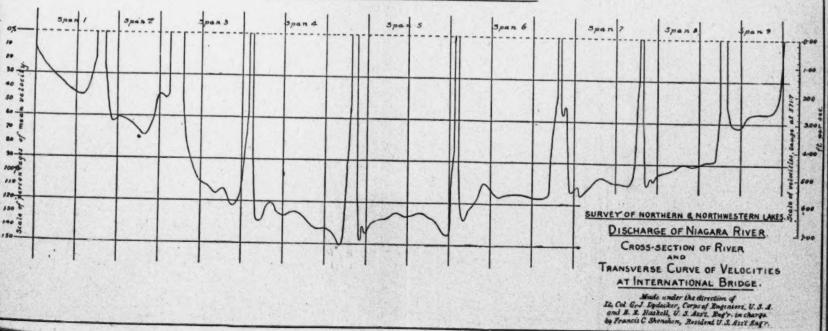
tial discharge in all these stations."

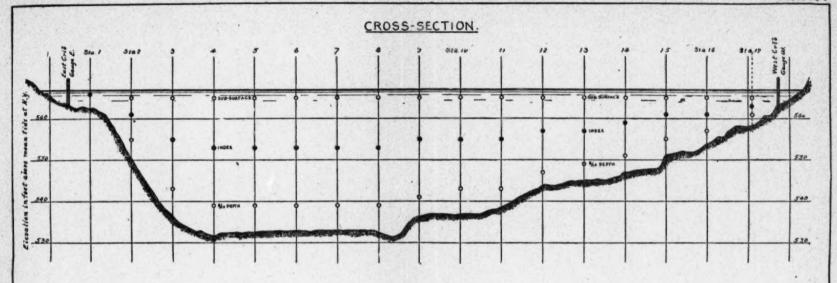
Chief of Engineers' Report, 1900, Appendix III, pages 5338, 5340-44.

From the report supra of Mr. Francis C. Shenehon, Assistant Engineer, dated Buffalo, July 18, 1900, are inserted opposite hereto plates 5, 6 and 7 which appear in said report opposite page 5360.

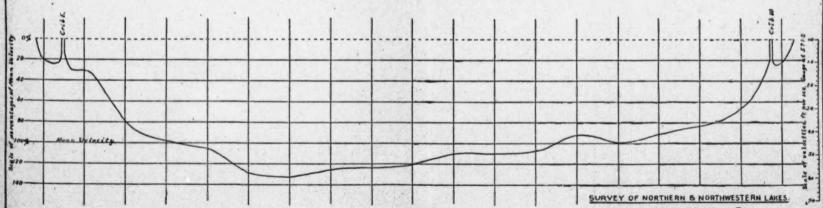








CURVE OF VELOCITIES AT 1/10 DEPTH.



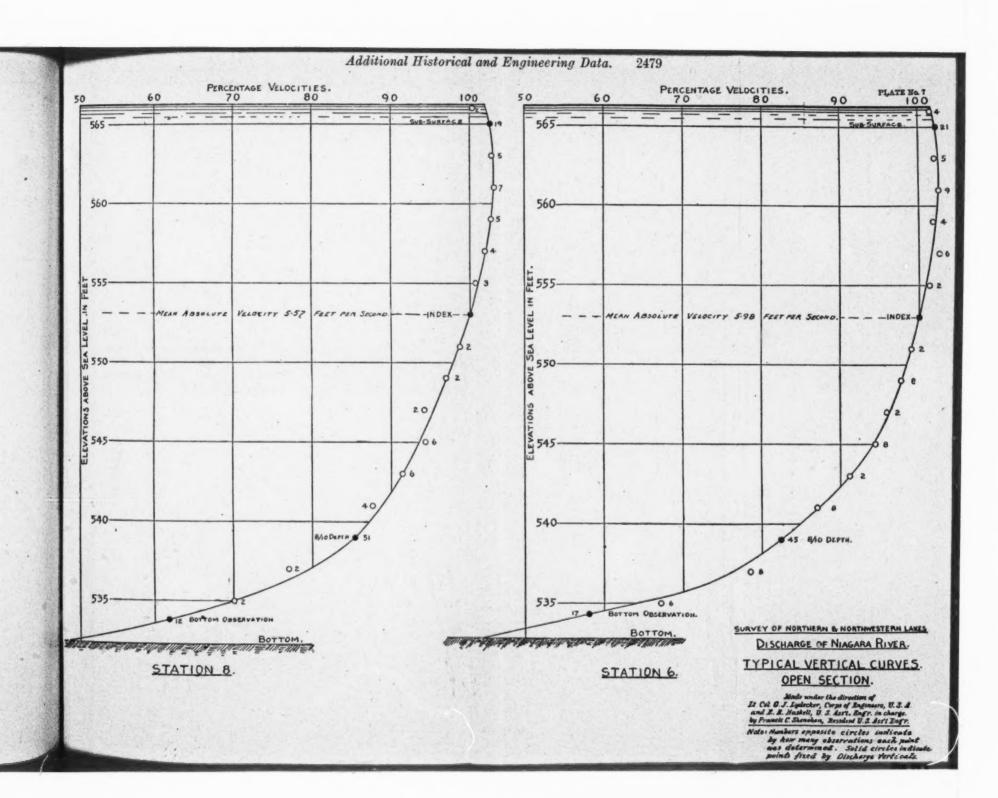
DISCHARGE OF NIAGARA RIVER.

CROSS-SECTION OF RIVER

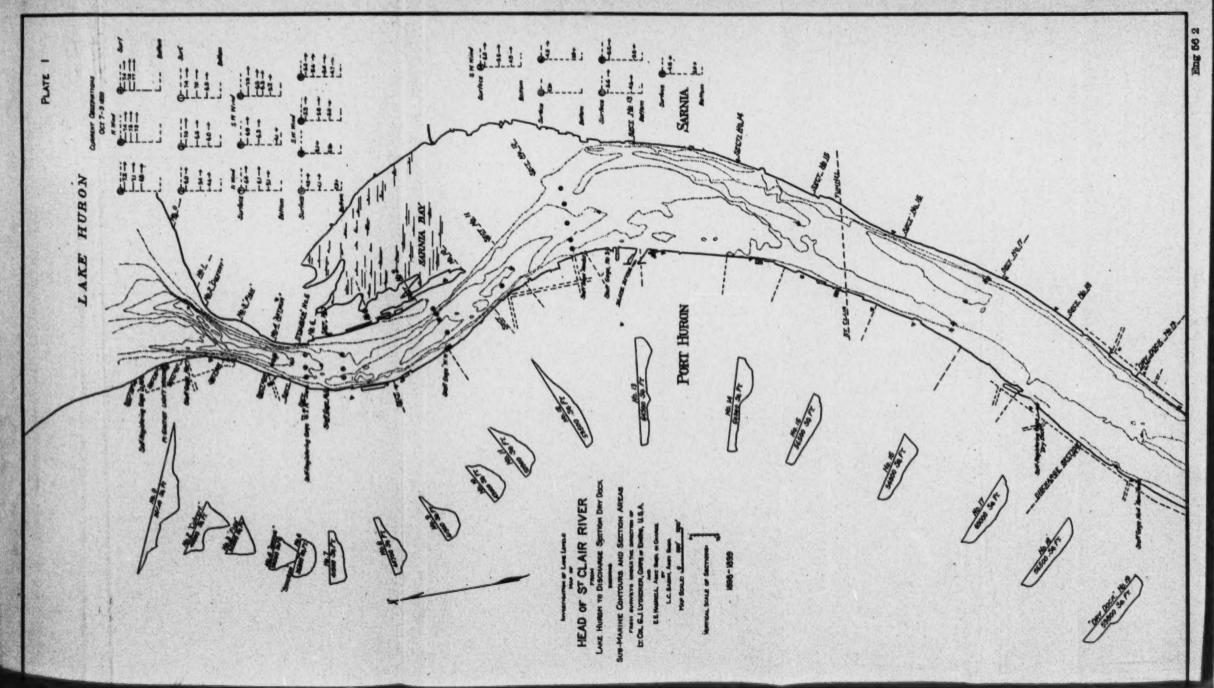
TRANSVERSE CURVE OF VELOCITIES

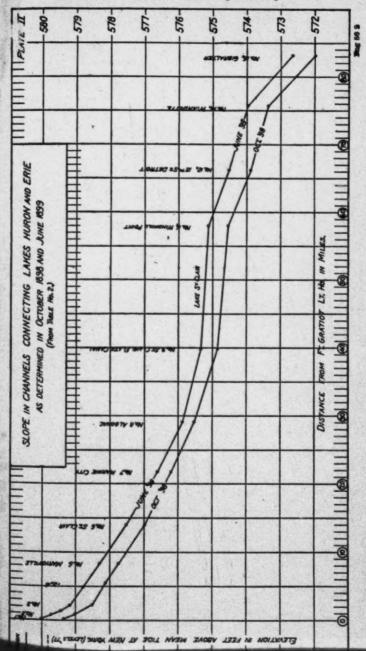
ON OPEN SECTION

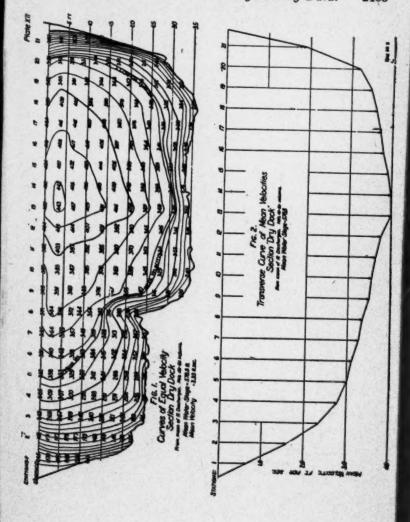
Mails under the direction of Lt. Col. G. T. Lydecher, Corps of Engineers, V. S. A and Z. E. Hashell, V. S. Asst. Ang'r. in charge by Francis C. Shenchem, Resident V. S. Astl. But.



From the Report of Mr. L. C. Sabin, Assistant Engineer, on the Discharge of the St. Clair River, made July 1, 1900, are inserted opposite hereto Plates 1, 2 and 12, which appear in said report of Mr. Sabin opposite page 5400.







EXTRACT FROM REPORT OF CHIEF OF ENGINEERS, 1902, APPENDIX EEE, BEING EXTRACT FROM THE REPORT OF MR. F. C. SHENEHON, ASSISTANT ENGINEER, DATED OGDENSBURG, N. Y., JULY 7TH, 1902, p. 2792:

"The Ontario-St. Lawrence Basin is a series of linked peels, each pool being held intact and its rate of fluctuation regulated by the natural dam of weir at its foot. The Lake Ontario and Upper St. Lawrence pool is dammed by the Galops Rapids shallows. The second pool, reaching from the foot of the Galops to the head of Ogden Island, finds its regulating weir at the Rapids Plat. Below this the reach from Morrisburg to the head of the Cornwall Canal is governed by the Long Sault Rapids orifice. Beyond this is the Lake St. Francis pool and a new series.

The practical importance of this formation from the point of view of river gauging lies in the fact that each of these natural weirs may be calibrated by a single set of discharge measurements, as at Three Points, a discharge table constructed for each, and the volume of flow henceforth is shown by the gauge reading at the head

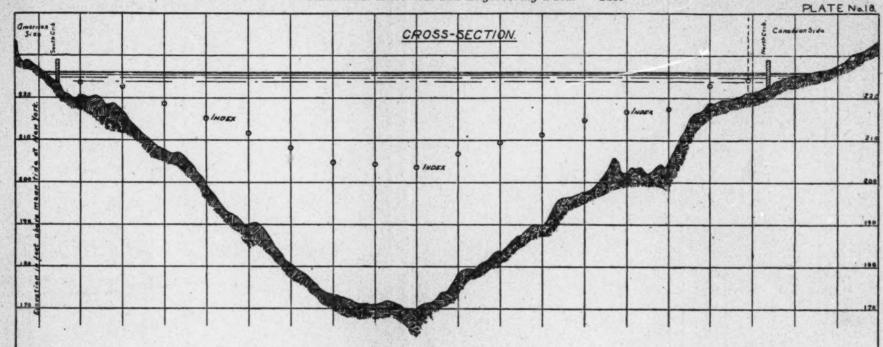
of the rapids or the crest of the weir."

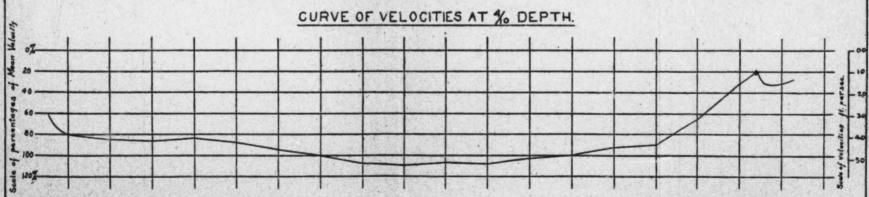
Chief of Engineers Report 1902, Appendix EEE, page 2792.

2400

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Opposite hereto is shown Plate 18 prepared in connection with report of Mr. F. C. Shenehon, which appears opposite p. 2792, supra.





Transferre Corve is Mean Indea Velocity by Table 19
Commission Velocity is previous from above by Olympins
by Weighted Mean Velocity of all Stations, 479

70

SURVEY OF NORTHERN & MORTHWESTERN LANCE.

ST LAWRENCE RIVER

CHOSS-SECTION OF RIVER

TRANSVERSE CURVE & VELOCITIES.

ON THREE-POINTS SECTION

Extract from the Report of Francis C. Shemehon. P. 2803 supra.

TABLE No. 19.—THREE POINTS SECTION, ST. LAWRENCE RIVER.—STATION ELEMENTS.

	V) con confe				88	Stations.				
	Section Gauge 226.03. Depth at station. Width. Width. Area—equare feet. Approximate index velocity. Vertical. Transverse. Direction. Combined. Direction angle. Percentage discharge.	4.7 88 86 11.711 1.711 1.888 1.956 1.956 1.70 S.	2.7 1000 3.19 .908 .908 .908 11.1	21.2 11.948 4.33 1.948 1.858 14°8. 14°8.	23.8 100 1.46 4.46 1.46 9°S.	2793 4.79 4.79 877 877 877 871 708.	38.479 4.93 4.93 6.90 6.90 6.90 6.90 6.90	2.4 100 100 5.15 5.19 5.89 8.99 8.99	47.6 1000 4,880 5.11 1 1 1 10.8 10.8	56.1 1000 5,530 6.26 6.26 6.26 1000 12.4 12.4
						Stations.				
	Elements. Section Gauge 226.03.	100	п	12	13	22	15	16	11	Veighted means (total)
	Depth at station Width Area—equare feet Approximate index velocity	5,476 5,476 5,20	5.242 5.242 4.81	45.3 100 1.52 1.53	3,567	2,686	18.3 1,788 4.14	9.1 1001 4.07	5.3 100 3.83	1,686 51,001 4.79
10	Coefficients— Vertical Transverse Dissection	920	22.18	900	.896	920	.927	1.020	985	808
600	Combined Direction angle Percentage discharge Weight used	11.8 11.8	6°N. 10 10	80.8 8.3.8	50 N. 6.1.	6°N. 4.5	8° N. 3.1.	918 8°N. 1.8	.914 10° N.	8

Additional Historical and Engineering Data. 2493

Extract from a Report by L. C. Sabin, Asst. Engineer, dated Port Huron, Mich., June 30, 1902.

TABLE No. 5.—DISCHARGE OF ST. CLAIR RIVER.

(Measurements at section Dry Dock during winter of 1900-1901 when river was partially blocked with ice.)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
(SIME	100 500		01	Observed d						Results	from equation	on No. 3			Result	ts from equation	ion No. 2	
No. of measure- ment	Date		r levels (al de at New		G.T.R.	G.T.R.	Meters used	Observed discharge Q (cubic feet		Discharge computed by equation 3		observed	Residual fall (computed	Q-12,000 (G.T.R. -579.2) (cubic feet	Discharge computed by equation 2	observed)	Fall f ₂ computed for observed discharge	Residual fall (computed
ment		G.T.R.	M.B.R.	D.D.	M.B.R.	D.D.		per second)	per second)	(cubic feet per second)	(cubic feet per second)	discharge by equation 3	y observed)	per second)	(cubic feet per second)	(cubic feet	by	observed)
37 68 69 70 71 72 73 74 75 77 78 112 113 114 115 116 117 118 119 120 121 122 123 124 126 127 128	1901 Jan. 2 4 7 8 9 10 11 14 15 30 Feb. 2 Mar. 25 29 30 Apr. 1 2 5 10 11 12 13 15 16 19 24 25 26 of Engineers	0.060 579.879 9.851	9.834 9.784	8.368 8.362 7.662 8.271 7.854 8.015 7.891 8.008 9.277 9.067 8.506 8.167 7.963 7.789 7.669 8.965 9.850 9.700 9.541 8.663 8.490 580.142 579.965 9.756 9.675	. 448 . 417 . 528 . 468 . 531 . 483 . 463 . 106 . 089 . 271 . 512 . 499 . 474 . 386 . 144 . 037 . 048 . 067 . 204 . 342 . 422 . 422 . 422 . 423 . 633 . 646 . 646	.905 .835	7A, 11B 7A, 11B 7A, 11B 7A, 11B 7A, 10B 7A, 10B, 11B 7A, 10B, 11B 7A, 10B 7A, 10B 7A, 10B 7A, 11B	B 185,200 175,700	194,100 184,500 175,500 167,900 195,300 182,100 188,000 180,400 94,100 94,000 151,900 198,200 195,800 191,400 168,200 108,400 66,200 73,100 82,100 126,900 163,000 178,400 66,900 771,400 84,000	190,900 181,000 189,300 168,000 193,600 179,300 191,300 182,100 182,100 184,500 95,500 146,500 190,300 186,600 179,600 161,800 115,200 74,700 80,300 89,600 133,800 163,200 176,900 83,000 72,500 70,700 90,800	-4,900 -3,200 -5,000 -8,300 -1,600 +2,400 +6,100 +6,400 -700 +7,800 +1,000 -3,600 -6,900 -6,500 -5,900 +2,600 +5,700 +7,000 +1,100 +2,700 +1,100 +2,700 +1,100 -3,000 +1,500 +1,500 +1,500 +3,000 +1,500 +3,000 +1,500 +3,000 +1,500 +3,000 +1,500 +3,000	Feet 0.530 .468 .413 .370 .539 .454 .490 .443 .468 .087 .087 .287 .287 .560 .543 .515 .372 .124 .036 .046 .062 .184 .345 .429 .035 .037 .044 .065	Feet +0.032 +.020 +.020047 +.011041040 +.005019002 +.016 +.048 +.044 +.041014020001002005020 +.006002001002001002001002001	193,800 184,500 175,700 169,600 195,300 183,200 188,600 175,700 185,100 93,500 93,900 152,200 198,300 196,400 170,000 108,400 64,600 71,800 81,200 126,600 162,900 178,400 63,200 65,200 70,100 82,700	193,500 183,600 172,400 163,700 196,700 179,800 191,600 181,700 187,000 97,800 89,200 145,300 197,400 198,000 179,100 152,000 101,400 74,200 81,800 129,600 151,100 86,200 73,200 79,700 98,900	- 2,300 - 600 - 1,900 + 4,000 + 1,500 + 2,900 + 6,400 + 5,800 - 4,800 - 4,800 - 4,800 - 4,900 - 7,200 - 7,100 + 200 - 7,100 + 900 - 7,100 - 7,200 - 1,100 - 7,200 - 1,100 - 7,200 - 1,100 - 7,200 - 1,100 - 3,000 - 4,100 - 3,000 - 4,100 - 3,000 - 4,100 - 7,200 - 3,000 - 4,100 - 7,200 - 7,100 - 7,200 - 7,200 - 7,200 - 7,100 - 7,200 - 7,200	Feet 0.893 .815 .734 .684 .908 .798 .845 .783 .815 .208 .210 .552 .936 .918 .882 .687 .280 .099 .122 .157 .381 .632 .757 .095 .101 .117 .162	Feet +0.020 +.010 +.015033013026060052052054 +.058 +.057 +.036001 +.006 +.019006 +.054 +.059033 +.007005014

Chief of Engineers' Report, 1902, Appendix EEE, page 2835.

TABLE No. 6 .- Discharge of St. Clair River.

[Measurements at Section Craig during winter of 1900-1901 when river was partially blocked with ice.]

1.	2.	8. `	4.	6.	8.	9.	10.	11.	12.	13.	14.
-		Ob	served d	sta.			1	tesults fro	m equation	on No. 8.	- 1
ment		above m	levels ean tide v York.	Fall		Ob- served	Q- 10,000 (G. T.	Dia- charge com-	Resid- ual dis- charge (com-	Fall fa com- puted for ob-	Residual fal
No. of measurement	Date.	G. T. R.	M. B. R.	from G. T. R. to M. B. R.	at 0.4	charge C (cubic feet per second).	R.— 879.2) (cubic feet per second).	puted by equation 8 (cubic feet per second).	puted— ob- served) cubic feet per second.	served dis- charge by equa- tion 3.	(com- puted- ob- serv- ed).
799 50 51 51 51 51 51 51 51 51 51 51 51 51 51	1901. Feb. 4 5 6 7 7 8 12 16 19 20 22 23 25 26 27 7 Mar. 1 2 4 6 6 7 7 8 9 9 9 11 12 12 14 16 16 16 16 16 16 16 16 16 16 16 16 16	Feet. 579, 579 558 508 508 509 509 509 509 509 509 509 509 509 509	Pect. 579, 482 579, 483 190 0.077 916 143 398 612 240 0.577 178 578, 569 578, 569 578, 569 578, 569 579, 340 579, 340 579, 340 579, 341 177 579, 341	Feet. 0.098 .096 .096 .116 .116 .116 .116 .116 .116 .116 .1	10 B. 11 B.	160, 000 103, 800 100, 800 100, 800 102, 100 101, 800 111, 800 112, 200 111, 600 106, 500 106, 500 111, 600 106, 500 111, 600 106, 500 111, 800 111, 800 111, 800 111, 800 111, 900 112, 800 113, 900 115, 800 116, 800 117, 800 118, 800 119, 800 119, 800 110, 800 110, 800 111, 800 112, 800 112	96, 300 100, 400 99, 600 100, 900 100, 900 102, 900 103, 800 104, 200 110, 800 106, 700 106, 800 110, 700 106, 800 110, 700 111, 900 111, 900 112, 900 112, 900 113, 900 114, 300 115, 500 117, 600 117, 600	102, 500 100, 500 106, 500 106, 500 106, 500 104, 500 102, 100 103, 100 104, 100 101, 100 102, 100 105, 400 107, 500 101, 500 101	+ 2,500 - 2,900 - 4,700 - 4,700 - 4,700 - 6,500 - 7,500 - 7,500	Feet. 0.092 102 102 102 103 108 111 111 126 120 116 124 124 124 124 124 124 125 126 126 126 126 126 126 126 126 126 126	Pect

Note.—The range in value of observed fall $i_1 = G$. T. R.—M. B. R., is as follows: A. No. 84, 0.03 to 0.14. B. No. 87, .02 to .12. C. No. 96, .00 to .13. D. No. 86, .11 to .23. E. No. 101, .06 to .16.

TABLE No. 7 .- Effect of ice in St. Clair River during winters of 1900, 1901, and 1902.

1	2.	. 1.	4.	8.	6.	7.
			Discharge	Differe	nce, or effec	of ice.
Date.	Elevation of Lake Huron at Sand Beach.	Discharge of St. Clair River by equation 4 of 1900, cubic feet per second.	from fall at head of river by equations Nos. 2 and 8, cubic fact persecond.	Cubic feet per second.	Depth Lake Michigan- Huron.	Depth Lak Erie
January 1900. February March	Pact. 579. 86 579. 88 579. 42 579. 53	188, 100 188, 100 183, 900 196, 006	147, 300 139, 200 138, 300 173, 200	35, 800 48, 900 57, 600 12, 600	Poet. 0.07 .09 .13 .08	Pert0.1
Total for winter					.31	
December	580.02	198, 300	191, 100	4,200	.01	
January 1901. February March April	579. 77 579. 64 579. 62 560. 10 560. 31	190, 600 188, 100 187, 700 196, 800 200, 860	160, 360 102, 200 133, 900 180, 500 169, 000	\$0,300 85,900 56,900 66,300 11,800	.06 .18 .11 .14 .02	=
Total for winter					.82]
December	879.60	187, 500	174,800	15,000	.08	
JanuaryFebruary	579. 51 579. 31	185, 800 181, 800	194, 700 129, 100	60, 900 52, 700	:13	Ξ:
Total for winter					27	

EXTRACT FROM REPORT OF MR. MUERAY BLANCHARD, JUNIOB, ENGINEER, DATED, DETROIT, MICH., JUNE 30, 1902, CHIEF OF ENGINEERS REPORT 1902, App. EEE, p. 2856.

"Report of Mr. Murray Blanchard, Junior Engineer.
United States Lake Survey Office,

Detroit, Mich., June 30, 1902.

Major: I have the honor to submit the following report on the resurvey and discharge measurement of De-

troit River.

The outfit used on this work was brought from Port Huron on July 5, 1901, and is the same as used for the discharge measurement of the St. Clair River. After receiving the outfit on May 15, 1901, from Mr. L. C. Sabin, assistant engineer, the St. Clair River discharge measurements were continued until July 1, 1901. In June, 1901, a hydrographic resurvey was also made at the head of St. Clair River, on the four sections established by Mr. Sabin in 1900, to test the permanence of the regimen. The results of this survey and of the St. Clair River discharge measurements will be reported by Mr. Sabin."

P. 2869.

"Vertical curves.—The multiple meter outfit and the method of making the observations for the determination of the vertical curves was practically the same as given in Mr. Sabin's report on the St. Clair River discharge measurements for 1900, with the following exceptions: A hole was bored through the body of each meter and the meters were suspended by a single one-fourth inch plow-steel cable passing through each. Clamps on the cable under each meter supported them at the tenths of the depth. Insulated wires were run along the outside of the cable down to each meter to enable the use of a small cable.

Stringing the meters on a single cable overcomes some of the disadvantages encountered in suspending the

meter in a gimbal clamped between two cables.

The lowest meter was set about 2 feet from the river bed and the top meter was 1 foot below the water surface. The space between these meters was divided into ten equal parts and a meter placed at each point of division. After seven or eight runs of different lengths had been taken at each depth, the cable was reeled in the amount of the spacing, so that for the second position each meter came to the elevation occupied by the meter above during the first run, except the top meter, which came out of the water and was not used after the first run. A like number of runs were taken in the second position and the meters again raised the same amount. In these three sets or positions the bottom point has been occupied by one meter (in the first run only), the ninetenths point run by two meters, while at all other points there has been a different meter in each of the three sets. By combining the three sets of runs the errors of meter rating and other errors of observation are largely corrected.

All of the stations were occupied in one week. A complete set of observations for three or four stations, consisting of twenty or more runs on each station, could be made in one day. The average time of taking twenty runs at a station (total length of runs being about sixty-five minutes) was one hour and thirty-seven minutes. On one station twenty runs were completed in one hour and twenty minutes, and the longest time required was two hours. With a single meter this amount of vertical curve observing would require at least twenty-eight days of ten hours each. A list of the observations is given in Table No. 8.

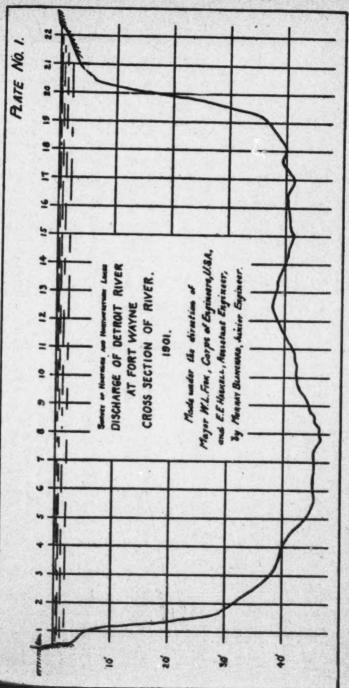
TABLE NO. 7. COEFFICIENTS AT TENTHS OF DEPTH.

STATION	Sarface	0.1	0.3	0.3	0.4	0.5	9.0	0.7	8.0	0.0	Bottom
1.80	0.867	0 867	0.886	0.914	0.945	0.978	1.026	1.078	1.152	1.237	1.335
	040	PAR	800	ROR	031	926	1.030	1.008	1.183	1.283	1.40
	200	900	020	200	032	071	1 000	1.084	1.143	1.268	1.48
	200	000	810.	010	000	020	1 000	1 061	1 134	1.231	1.36
	93.	100	ONE.	218.	0000	000	100	1 AM	1 197	1 255	1.480
	216	200	208.	010.	2000	080	200	1 OAR	1 120	1 248	1.45
	.915	200	1980	216	0000	000	000	1 085	1 115	1 244	1.44
4	808	108	200	710.	200	000	100	1.084	1 191	1 250	1 613
	.937	106	268	88.	930	950	1 000	500	1 123	1 271	1.590
	888	800	28.	100	38	200	000	90	1 113	1 284	1.470
	200	988	200	ola.	2000	2000	000	1 000	101	1.208	1.40
	.017	108.	88	778.	100	200	000	1 045	1 120	1.273	1.58
	200	1/9.	288.	TIR.	200	1.20	2000	1 042	100	1 227	1.54
	8	.876	988	216.	200	118.	38	500	1111	1.254	1.63
	118.	100	38.0	016.	2000	030	200	1	1 126	1.274	1.60
	988.	.875	988	98.	000	000	900	1 050	1 126	1.245	1.46
	.940	289.	288	208.	008.	200	200	1 069	1110	1 230	1 46
	.872	.876	988	816.	074	000	30	1.00	141	1 273	1.52
	988	028.	6/8	208.	2000	OKK	000	1 061	1.130	1.282	1.79
	99	200	1 010	985	198	. 967	.967	006	880	1.031	1.12
	000	040	000	000	025	080	1.001	1.052	1.127	1.252	1.50

Station is in shallow water and the curve is abnormal. (See plate No. 3.) a Station 20 is omitted from mean. "Every run was plotted to detect any large errors, and a single vertical curve of velocities was derived and plotted for each station. From the velocities at the tenths of the depth the coefficients for reducing the observed velocity at each tenth to the mean velocity of the station were derived. These coefficients are given in Table No. 7. The vertical curves of velocities for each station are shown on plate No. 3.

	Dates	Dates stations	1	Total			0	Observations	90	
STATIONS	August	were occupied. ugust September	occu- pied	(meter positions)	Curves	700 sections	600 sections.	300 sections.	200 sections.	100 sections.
+ 30.	88		1	64	1			23	*	+
	88		-	100	1		001		4	13
	88	******	-	00	-		00 (09	15
	8		-	00	-		001		001	21
	8	9	04	9	00	******	2		0	25
	a		-	001	-		00 (-1	13
	SI.		-	0	29		201	0	2	I,
	E		-	00	-		00	1		9
	8	0	64	-	00	******	9		9	8:
	8			000	-		000		.0	9:
	N		-	00	-	1	C4 (-	91
	7	******	-	00 (-		000	1	90	=
	7		-	001	-		00		200	14
	7	*****	-	100	-		000		01	9:
	13		-	00	1		69		1	14
	131		-	00 (-		000		-	97
	22		1	001	~		29 (000	14
	H		-	00 (-	-	C9 (000	1:
19.	17		-	00	-		000	******	790	07
	22		1	07	-				10	10
Total	7 days			. 89	28	60	89	6	63	311
	The second second							1		

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COPY OF PLATE NO. 1 WHICH APPEARS IN SAID REPORT OPPOSITE PAGE 2870.

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TABLE NO. 9.—SUMMARY OF MEASUREMENTS OF DISCHARGE OF DETROP RIVER, MADE IN 1901.

Table Point Poi			Wat	er levels al	bove noon tid	le at Ne		RANG.	
Description Point B. Description Point B. Description Point B. Description Point B. Description Point Po	- S .	Date of	Windmill	Fort	Amheret-		Fall.		Discharge in cubic
2. July 19 574,98 574,11 571,99 0.57 2.12 2.99 205,93 3. July 22 575 574,11 571,87 89 2.24 3.13 208,71 4. July 23 574,95 574,11 571,87 89 2.24 3.13 208,71 4. July 23 574,95 574,11 572,07 84 2.04 2.88 201,77 6. July 28 575,02 574,25 572,21 82,27 7.77 1.88 2.65 107,33 7. July 27 575,08 574,25 574,25 572,27 7.77 1.88 2.65 107,33 9. July 30 574,92 573,88 571,53 94 2.45 3.89 20,8 9. July 30 574,92 573,88 571,53 94 2.45 3.89 20,3 9. July 31 575,03 574,15 571,75 88 2.40 3.26 215,3 11. Aug. 1 575,03 574,15 571,75 88 2.40 3.26 215,3 11. Aug. 3 575,05 574,25 572,21 80 2.04 2.85 103,9 12. Aug. 15 574,84 574 571,68 84 2.32 3.17 199,4 12. Aug. 15 574,84 574 571,68 84 2.32 3.17 199,4 12. Aug. 16 574,93 574,15 572,01 78 2.14 2.92 107,14 15 Aug. 16 574,93 574,15 572,01 78 2.14 2.92 107,14 15 Aug. 16 574,93 574,16 571,64 87 2.33 3.20 202,8 11. Aug. 17 574,94 574,16 571,64 84 2.42 3.2 33 1.7 199,4 11. Aug. 17 574,94 574,16 571,16 84 2.42 3.2 33 1.7 199,4 11. Aug. 17 574,94 574,16 571,16 84 2.42 3.2 33 3.20 302,8 17 18 18 Aug. 19 574,94 574,16 571,17 8 82 2.14 2.92 107,14 15 18 Aug. 19 574,94 574,16 571,17 8 82 2.14 2.92 107,14 15 18 Aug. 19 574,94 574,16 571,18 83 2.2 3.4 3.16 202,7 17 18 Aug. 17 574,94 574,16 571,18 83 2.2 3.4 3.16 202,7 19 18 18 Aug. 19 574,94 574,16 572,05 78 2.11 2.89 107,18 19 10 Aug. 19 574,94 574,12 571,78 83 2.2 3.4 3.16 202,7 19 19 19 574,94 574,19 572,06 81 2.11 2.92 20,3 10 10 10 10 10 10 10 10 10 10 10 10 10	No.		Point.		burg. C(W't'd).	A-B.	B-C.		feet per
2. July 20 574,93 574.05 571.91 88 2.14 3.02 200,24 4. July 23 575 574.11 571.87 89 2.24 3.13 208,7 5. July 25 575 574.11 572.07 84 2.24 3.13 208,7 6. July 26 575 574.95 574.11 572.07 84 2.204 2.88 201,97 6. July 27 575.08 574.25 572.17 82 2.07 2.89 206,01 7. July 27 575.08 574.26 572 72 2.2 2.8 3.06 206,01 8. July 30 574.92 573.98 574.25 572.37 77 1.88 2.65 197,30 9. July 31 574.97 574.14 572.14 83 2 2 2.81 202,11 0. Aug. 13 575.05 574.84 577.18 571.75 88 2.40 3.26 215,8 11. Aug. 15 574.84 574.95 574.15 571.75 88 2.40 3.26 215,8 11. Aug. 15 574.84 573.97 571.64 8.84 2.32 3.17 199,4 13. Aug. 15 574.94 574.15 572.01 78 2.14 2.92 107,14 15. Aug. 16 574.99 574.00 571.64 84 2.42 3.27 199,14 16. Aug. 17 574.94 574.19 572.15 75 2.04 2.79 108,18 17. Aug. 19 574.94 574.19 572.15 75 2.04 2.79 108,18 18. Aug. 19 574.94 574.16 572.05 78 2.11 2.89 107,18 19. Aug. 19 574.94 574.16 572.05 78 2.11 2.89 107,18 19. Aug. 19 574.94 574.16 572.05 78 2.11 2.89 107,18 19. Aug. 19 574.94 574.16 572.05 78 2.11 2.89 107,18 20. Aug. 20 575 674.19 572.05 88 12.11 2.89 107,18 21. Aug. 19 574.94 574.16 572.05 78 2.11 2.89 107,18 22. Aug. 20 575 674.19 572.05 88 12.11 2.92 20,24 23. Aug. 20 574.96 674.13 571.98 83 2.15 2.98 20,24 24. Aug. 20 575 674.91 574.94 574.19 672.05 78 2.11 2.89 107,18 24. Aug. 19 574.94 574.16 572.05 88 1.2.11 2.99 20,24 25. Aug. 20 574.96 674.13 571.98 83 2.15 2.98 20,24 26. Aug. 20 575 674.19 572.08 88 2.15 2.90 108,48 27. Aug. 31 574.99 574.15 572.05 88 1.2.10 2.00 108,48 28. Aug. 29 574.96 674.13 571.99 84 2.20 3.04 202,18 29. Sept. 4 575.01 674.17 572.08 88 2.24 3.07 2.90 108,48 20. Aug. 20 574.96 674.13 571.99 84 2.20 3.04 202,18 21. Aug. 30 574.96 674.13 571.99 84 2.20 3.04 202,18 22. Aug. 31 574.99 674.12 571.78 82 2.34 3.16 202,70 23. Aug. 30 574.96 674.13 571.90 87 2.22 3.30 3.04 202,18 24. Aug. 30 574.96 674.13 571.90 88 2.22 3.30 3.04 202,18 25. Aug. 30 574.96 674.13 571.90 88 2.22 3.30 3.04 202,18 26. Aug. 30 574.96 674.17 577.00 89 2.24 3.07 2.90 108,48 27. Aug. 31 574.99 674.94 674.99 674.12 579.90 89									
3. July 22 575 574 11 571.87 89 2.24 3.13 208.76 6. July 25 675 574.18 572.11 82 2.07 2.89 205.01 6. July 27 575.08 574.26 572 77 1.88 2.65 107.30 7. July 27 575.08 574.26 572 72 2.26 3.06 205.01 8. July 30 574.92 573.98 571.53 94 2.45 3.39 205.01 9. July 31 574.97 574.14 571.53 82 2.08 3.06 205.01 10. Aug. 1 575.03 574.15 571.75 88 2.40 3.26 215.31 11. Aug. 3 575.05 574.25 572.21 80 2.04 2.59 103.01 12. Aug. 15 574.84 573.97 571.64 87 2.33 3.20 202.81 13. Aug. 15 574.84 573.97 571.64 87 2.33 3.20 202.81 14. Aug. 16 574.93 574.15 572.01 78 2.14 2.92 107.81 16. Aug. 17 574.94 574.19 572.15 75 2.04 2.79 108.91 17. Aug. 17 574.94 574.19 572.15 75 2.04 2.79 108.91 18. Aug. 19 574.94 574.16 572.06 78 2.11 2.89 107.81 19. Aug. 19 574.94 574.16 572.06 78 2.11 2.89 107.81 19. Aug. 20 575 574.94 574.19 572.15 75 2.04 2.79 108.93 10. Aug. 20 574.96 574.19 572.15 75 2.04 2.79 108.93 11. Aug. 3 574.94 574.16 572.06 78 2.11 2.89 107.81 12. Aug. 19 574.94 574.19 572.15 75 2.04 2.79 108.93 12. Aug. 20 574.96 574.19 572.06 78 2.11 2.89 107.83 12. Aug. 20 574.96 574.19 572.06 78 2.11 2.89 107.83 12. Aug. 20 574.96 574.19 572.06 78 2.11 2.89 107.83 12. Aug. 20 575 574.19 572.06 78 2.11 2.92 204.22 12. Aug. 20 575 574.19 572.06 78 2.11 2.92 204.22 12. Aug. 20 575 574.19 572.06 78 2.11 2.92 204.22 12. Aug. 21 574.96 574.15 572.06 79 2.19 2.98 205.73 12. Aug. 30 574.96 574.15 572.06 79 2.19 2.98 205.73 12. Aug. 30 574.96 574.15 572.06 79 2.19 2.98 205.73 12. Aug. 30 574.96 574.15 572.06 79 2.19 2.98 205.73 12. Aug. 20 575 574.19 572.06 79 2.19 2.98 205.73 12. Aug. 20 575 574.19 572.06 79 2.19 2.98 205.73 12. Aug. 20 575 574.19 572.06 79 2.19 2.98 205.73 12. Aug. 20 574 56 574.15 572.06 79 2.20 3.04 202.92 12. Aug. 21 574.96 574.15 572.06 79 2.20 3.04 202.92 12. Aug. 21 574.96 574.15 572.06 79 2.20 3.04 202.92 12. Aug. 21 574.96 574.15 572.06 79 2.20 3.06 203.06 205.0	1	July 19							
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34. Sept. 5 575 574.21 572.11 .79 2.10 2.89 198,3 35. Sept. 7 574.96 574.13 571.93 83 2.20 3.03 205,8 36. Sept. 7 575 574.16 573.82 571.75 .79 2.07 2.86 189,2 38. Sept. 17 574.61 573.82 571.75 .79 2.07 2.86 189,2 38. Sept. 24 574.77 573.92 571.76 85 2.16 3 204,7 39. Oct. 7 574.63 573.82 571.70 81 2.12 2.93 191,9 40. Oct. 8 574.52 573.67 571.36 .85 2.16 3 .204,7 41. Oct. 10 574.51 573.61 571.31 .88 2.30 3.16 192,0 41. Oct. 10 574.51 573.61 571.31 .88 2.30 3.16 192,0 42. Oct. 10 574.51 573.61 571.30 .90 2.31 3.20 201,1 43. Oct. 11 574.51 573.68 571.47 .83 2.21 3.02 190,9 44. Oct. 12 574.57 573.74 571.65 .83 2.09 2.92 189,8 45. Oct. 16 574.59 573.78 571.65 .83 2.09 2.92 189,8 46. Oct. 17 574.24 573.30 570.82 .94 2.48 3.42 197,8 47. Oct. 19 574.44 573.45 570.70 .99 2.75 3.74 214,8 48. Oct. 21 574.42 573.51 571.04 .91 2.47 3.38 199,7 47. Oct. 19 574.44 573.45 570.70 .99 2.75 3.74 214,8 48. Oct. 21 574.42 573.51 571.04 .91 2.47 3.38 199,7 49. Oct. 21 574.42 573.51 571.04 .91 2.47 3.38 199,7 49. Oct. 21 574.42 573.52 571.11 .91 2.14 3.05 195,7 50. Oct. 31 574.30 573.50 571.48 .80 2.02 2.82 182,1 51. Nov. 29 574.16 573.25 571.08 .90 2.17 3.07 191,8 53. Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191,8 54. Dec. 3 574.31 573.46 573.65 571.66 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.65 571.08 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.25 571.08 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.26 571.66 571.67 571.08 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.65 571.08 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.55 571.08 .90 2.17 3.07 191,8 55. Dec. 4 574.18 573.65 571.66 571.67 571.67 571.70 5					571.96				202,810
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40. Oct. 8									204,778
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42 Oct. 10									192,000
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45 Oct. 16 574.59 573.78 571.56 .81 2.22 3.02 192,9 46 Oct. 17 574.24 573.30 570.82 .94 2.48 3.42 197,2 47 Oct. 19 574.44 573.45 570.70 .99 2.75 3.74 214,8 48 Oct. 21 574.42 573.51 571.04 .91 2.47 3.38 199,7 49 Oct. 21 574.47 573.62 571.41 .85 2.21 3.05 195,7 50 Oct. 31 574.30 573.50 571.48 .80 2.02 2.82 182,1 51 Nov. 29 574.16 573.25 571.11 .91 2.14 3.05 195,7 52 Nov. 30 574.22 573.31 571.08 .91 2.23 3.14 193,5 53 Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191,8 54 Dec. 3 574.31 573.45 571.08 .90 2.17 3.07 191,8 54 Dec. 3 574.31 573.45 571.46 .86 1.99 2.83 197,8	- Line - Co. A.								190,980
46 Oct. 17 574.24 573.30 570.82 .94 2.48 3.42 197.8 47 Oct. 19 574.44 573.45 570.70 .99 2.75 3.74 214.8 48 Oct. 21 574.42 573.51 571.04 .91 2.47 3.38 199.7 49 Oct. 21 574.47 573.62 571.41 .85 2.21 3.05 195.7 50 Oct. 31 574.30 573.50 571.48 .80 2.02 2.82 192.1 51 Nov. 29 574.16 573.25 571.11 .91 2.14 3.05 195.7 52 Nov. 30 574.22 573.31 571.08 .91 2.23 3.14 183.5 53 Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191.8 54 Dec. 3 574.31 573.45 571.46 .86 1.99 2.83 197.8 55 Dec. 4 574.31 573.45 571.46 .86 1.99 2.83 197.8					571.65	.83			188,630
47 Oct. 19	Commercial Street				571.56 570.82	.81			197,20
48 Oct. 21 574.42 573.51 571.04 91 2.47 3.38 199.7 49 Oct. 21 574.47 573.62 571.41 .85 2.21 3.05 195.7 50 Oct. 31 574.30 573.50 571.48 .80 2.02 2.82 182.1 51 Nov. 29 574.16 573.25 571.11 91 2.14 3.05 185.7 52 Nov. 30 574.22 573.31 571.08 91 2.23 3.14 193.5 53 Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191.4 54 Dec. 3 574.31 573.45 571.46 .86 1.99 2.83 197.8 55 Dec. 4 574.16 573.95 571.46 .86 1.99 2.83 197.8									214.809
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51 Nov. 29 574.16 573.25 571.11 .91 2.14 3.05 195.7 52 Nov. 30 574.22 573.31 571.08 .91 2.23 3.14 193.5 53 Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191.4 54 Dec. 3 574.31 573.45 571.46 .86 1.90 2.83 197.8 55. Dec. 4 574.16 573.19 571 97 2.19 3.17 197.1 56.	50								182,180
52 Nov. 30 574.22 573.31 571.08 .91 2.23 3.14 193.5 53 Dec. 2 574.15 573.25 571.08 .90 2.17 3.07 191.4 54 Dec. 3 574.31 573.45 571.46 .86 1.99 2.83 197.5 55. Dec. 4 574.16 573.19 571 97 2.19 3.17 197.5		Nov. 29							196,700
84 Dec. 3 574.31 573.45 571.46 .86 1.99 2.83 197.8 85 Dec. 4 574.16 573.19 571 97 2.19 3.17 197.18		Nov. 30	574.22	573.31	571.08	.91	2.23	8.14	193,530
55 Dec 4 574 16 573 19 571 97 2 19 3 17 197.0									197,690
66 Dec. 10 574 573.14 571.20 .88 1.94 2.90 1772	85							3.17	197,170
	88	Dec. 10	574		571.20	.86	1.94	2.90	kur

Discharge Observations.-A substation occupied in place of station No. 1 was 95 feet from. Middle Base. Station No. 22 was 30 feet from the Canadian shore. As there is only a few feet of water and practically no current close to either shore, the discharge area was taken as from 30 feet outside of the fort wall to station 21 plus 50 feet, or 2,100 feet from the wall. The velocity at station 21 was always less than 0.5 foot per second. If we assume a velocity as high as 0.2 foot per second, the discharge for the end area between station 21 plus 50 and shore is only 30 cubic feet per second, or one one-hundredth of 1 per cent. of the total discharge. This area has been disregarded. Two runs of 200 seconds each were taken at each station. Meter No. 11 B remained at mid-depth, while meter No. 5 A occupied the three-tenths and seven-tenths depth successively.

A summary of the results of the measurements is

given in Table No. 9.

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05.900

The present data is considered insufficient for the de-

termination of a discharge curve.

Recorders H. H. Atwell, W. H. Vandeburgh, and C. L. Vandeburgh, who have assisted at different times in the field observations, have been careful and painstaking in the execution of the work assigned to them.

Very respectfully, your obedient servant,

MURRAY BLANCHARD, Junior Engineer.

Major W. L. Fisk, Corps of Engineers, U. S. A."

Chief of Engineers Report, 1902, Appendix EEE, pages 2856, 2869-2872.

EXTRACT FROM THE REPORT OF Mr. MURRAY BLANCHARD, JUNIOR ENGINEER, DETROIT, MICH., JUNE 30, 1903:

"Report of Mr. Murray Blanchard, Junior Engineer.
United States Lake Survey Office,

Detroit, Mich., June 30, 1903.

Major: I have the honor to submit the following report on the discharge measurements of the Detroit and St. Clair Rivers, under my charge during the past year.

At times when the discharge work could not be carried

on, stadia surveys were made along the river fronts of Detroit and Windsor, where recent changes have occured.

The field work was commenced on the Detroit River at section Fort Wayne (Detroit) one week before the beginning of the fiscal year, and four discharges not included in the summary of the last annual report were measured in June, 1902. The discharge measurements of Detroit River were continued until August 8, when the party, with the discharge outfit, including tug U. S. L. S. No. 2 and one catamaran, was taken to Port Huron. The next six weeks were devoted to the gauging of St. Clair River on section Dry Dock, at Port Huron. The section was resounded. Three stations were selected for vertical curve observations to determine whether there had been any change in the curve since the multiple meter observations of 1899, and about 30 curves were measured on each of the three stations. Forty-eight discharges were measured, the notes of which were turned over to Asst. Engineer L. C. Sabin for reduction.

Before returning to Detroit a survey was made on a portion of the shoal at the mouth of Black River where the steamer City of Rome grounded. This survey was

platted and has been reported.

On returning to Detroit October 1 the discharge measurements were resumed and continued until the 20th of November, when the field work was closed.

Discharge of Detroit River.—The discharge section at Fort Wayne was sounded at the beginning of the season with a 70-pound 'fish' weight suspended on a No. 9 galvanized wire. The heavy weight made the deflection of the sounding wire from the vertical considerably less than in the 1901 soundings. It appears that too large a deflection correction was applied to the soundings in 1901, so that a recomputation of the area for that year has been made by applying the corrections given in Table No. 1, found on page 5330, Appendix III, Report of the Chief of Engineers, United States Army, for 1900. This table, computed by Asst. Engineer F. C. Shenehon, has been tested on soundings made in the swift current of the Niagara River with various deflections. The close agreement of the two seasons' determinations of the partial areas on section Fort Wayne indicates that no scour has takes of

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place, and the discrepancy in the total areas has been attributed to errors of observation. The mean of the two determinations of the area has been used in computing all of the discharges summarized in this report, which accounts for the disagreement with the volumes of discharge summarized in the last report. The two area measurements and the mean value used are given in Table No. 1.

The meters were rated about once a month, and a rate comparison, whenever the meters were used, was made by running them side by side on the section at the same depth. The rating equations of the meters and their application are given in Table No. 2. A comparison of all the ratings made in 1901 and 1902 is shown in Tables Nos. 3 and 4.

Stations Nos. 4, 9, 15, and 20 were selected for vertical curve observations, and about 20 curves were measured at each station. A comparison with the 1901 multiple meter curves is shown on Plates Nos. 1 to 4. The coefficients at the 0.3, 0.5, and 0.7 depths are those used in the discharge computations. The mean of the discharges at these depths is used as one discharge, and the means of the three coefficients for each station agree closely for the two years, except for the shallow station No. 20, where the curve is abnormal and varies. The discrepancy on this station in the two years, although amounting to 2 per cent., would not affect the partial discharge more than 60 cubic feet per second, or 0.0003 of the average total discharge. Therefore the multiple meter coefficients have been used for both seasons.

In the two seasons 117 discharges have been measured, with a range of 1.6 feet in the Windmill Point or Lake St. Clair stage, of 2.5 feet in the Amherstburg or Lake Erie stage, and of 50,000 cubic feet per second in the discharge. Some of the observations were made when the river was rough and the wind strong, because such conditions are generally found with extreme stages and accompany a very high or low discharge. In such cases, however, there is generally a large fluctuation in the stage of Lake Erie and an uncertainty as to the effective stage of that lake.

In Table No. 6 the results of the discharge measurements for 1901 and 1902 are given, with the corresponding gauge readings at Windmill Point, Fort Wayne section, and Amherstburg.

Very respectfully, your obedient servant,

MURRAY BLANCHARD, Junior Engineer.

Maj. W. L. Fisk, Corps of Engineers, U. S. Army."

TABLE 1.-AREA MEASUREMENTS, 1901 AND 1902.

	Area for		
Station	1901	1902	Moan used
1	822	773	796
2	3.090	3,024	3,057
	3,760	3,761	3,760
	4.021	4,019	4,020
	4,421	4,435	4,42
2	4,571	4,591	4,58
D	4,582	4,623	4,00
	4,648	4,640	4,64
	4.474	4,490	4,48
	4,285	4,294	4.20
0	4.154	4.182	4 10
	3,910	3,936	3,92
2		3,912	3,88
3	3,862		4.04
4	4,022	4,068	4,18
5	4,117	4,161	4,11
6	4,107	4,131	
7	4,138	4,190	4,16
8	3,959	3,961	3,96
9	3,624	3,555	3,00
0	1,742	1,717	1,72
1	383	385	38
Total	76,692	76,848	76,77

Chief of Engineers' Report, 1903, Appendix FFF, pages 2813-2814.

TABLE No. 5.—COMPARISON OF 1901 AND 1902 COEFFICIENTS AT TENTHS OF DEPTH.

Sta- tion	Year	Method	No. of obs.	0.3	0.5	0.7	Mean o 0.3, 0.5 and 0.7
4	1901	Multiple meter	20	0.912	0.970	1.061	0.981
500	1902	Two meter		.923	.972	1.036	.977 .975 .981
9	1901	Multiple meter	45	.907	.967	1.050	.978
A PARTY	1902	Two meter	. 20	.907	.969	1.066	.981
15	1901	Multiple meter		.906	.959	1.049	.971
	1902	Two meter	20	.915	.958	1.035	900
20	1901	Multiple meter		.982	.957	.969	.900
	1902	Two meter	. 21	.985	.989	1.009	.994

	L'acharge observed	201, ft. eec. 201, 770 210, 77
ratio	Second	တ ကွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွဲဆွ
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=	A-C	88258888888888888888888888888888888888
Fall	A-B	88822868288888281285688882828282828
feet above	Amherst- burg	224888888888888888888888888888888888888
Water surface—570 feet above mean tide at New York	Fort Wayne	1811288884288828882888288828882888
Water sur	Windmill Point A	\$ 4 4 5 4 6 6 5 5 4 4 6 6 4 4 4 4 4 4 4 4
rerage)	Velocity (miles per bour)	~###
Wind (average)	Direction from which blows	E E E E E E E E E E E E E E E E E E E
	Date of observation	1901 July 22 July 22 July 22 July 22 July 22 July 23 July 23 July 27 July 20 J
Number	measure- ment	100400000000000000000000000000000000000

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	Discharge	202,570 202,570 202,570 203,200 207,210 203,210 203,210 203,240 193,560 193,660 194,470 197,900 197,900 197,900 197,900 197,900 197,900 197,900 197,900 197,900 197,900 197,900
ratio	Second	ۺؙۊؙ؈ؚٛ؈ؙ؈۬ۺۺٷ؈ؚٛ؈ؚؗ؈ؗ؈ؗ؈؈ؗ؈؈؈؈ ٢٠٢٢-٢٠٢٢-٢٠٢٢-٢٠٢٢-٢٠٢٢-٢٠٢٢-٢٠٢٢
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11	A-C	8288512886868686666666666666666666666666
Fall	A-B	<u>8886846888888888888</u>
570 feet above New York	Amherst- burg	11.28.88.88.88.88.88.88.88.88.88.88.88.88.
face 570 i	Fort Wayne B	* 4 4 4 4 4 8 8 8 8 8 8 8 8 8 8 8 8 8 8
Water surface mean tide at	Windmill Point A	62858252588345882328888888888888888888888
rerage)	Velocity (miles per hour)	&>>>>>574%7474746464646555564
Wind (average)	Direction from which blows	NW WEW WEW WEW WEW WEW WEW WEW WEW WEW W
	Date of observation	Bept. 4 Sept. 6 Sept. 7 Sept. 7 Sept. 7 Sept. 17 Oct. 11 Oct. 12 Oct. 13 Oct. 14 Oct. 15 Oct. 15 Oct. 15 Oct. 16 Oct. 17 Oc
Number	of measure- ment	232252222232323232323232323232323232323

1	Discharge	cu. ft. sec. 185,500 184,100 184,100 184,100 184,100 184,100 206,540 2
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shove Fall	A-C	00000000000000000000000000000000000000
F	A-B	24.00.1 1
-570 feet above t New York	Amherst- burg	988888888888888888888888888888888888888
rface 570	Fort Wayne B	40444444444444444444444444444444444444
Water surface mean tide at	Windmill Point A	44446668846866666666666666666666666666
Wind (average)	Velocity (miles per hour)	234~~2520022~004~252020~15000~20~2
Wind (a	Direction from which blows	SWA WWW WWW WWW WWW WWW WWW WWW WWW WWW
	Date of observation	1902 June 25 June 27 July 28 July 28 J
	measure- ment	288888888888888888888888888888888888888

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	Discharge	cu. ft. sec.	188,520	180,140	198,880	184,390	191,830	183,010	195,690	195,380	170,120	188,790	200,900	192,880	184,150	192,830	208,100	199,530	188,420	185,450	201,230	192,080	107 000
ratio	Second	2	600	00.00	3,	0,0	, 60	6,0	0,00	000	0,00	6,0	0,00	6	i, c	500		.3, .7	.3, .7	,00	0,0	0 00	0
Depth ratio	First	1		, ro, ro														.5, .3	.5, .3	6,	0,0	0 00	
	A-C	0 79	2.37	2.5	2.81	1.93	25.5	2.51	2.57	2.44	2.36	2.45	2.76	2.40	25.25	2.75	3.03	2.38			83		
Fall	A-B	1.0	722	.75	83	70.	12	17.	7.5	8	20.00	26.1	20	8	.72	4.8	- 36	62.	.70	.62	98.	202	200
eet above	Amberst- burg	02.0	2.62	2.12					25.15								1.55	2.26	2.04	2.18	1.34	1.0	20.7
ater surface—570 f	Fort Wayne B	1	4.27	4.07	3.80	35.25	4.14	4.06	88	4.06	2.10	4.12	200	3.88	3.90	3.61	3.63	3.82	3.91	3.88	3.47	3.02	30
Water sur	Windmill Point	07 1	80.4	4.82 K 10	4.63	4.79	8.5	4.76	4.72	4.74	4.87	4.93	4.65	4.58	4.71	4.70	4.58	4.64	4.61	4.50	4.33	4.38	9.10
rerage)	Velocity (miles per hour)		22	17	22	75	2=	12	90	10	2 2	121	200	19	91	10	14	12	9	10	14	2:	1.3
Wind (average)	Direction from which blows	,	WNW	WS.	WNW	NNE	ENE ENE	8W	ME	SSE	ENE	NE	MNN	WNW	NNE	3000	MN	MN	SRW	SW	M	A A	N. P.
	Date of observation	1902	Oct. 7	00t	Oct. 14	Oct. 16	Oct do	Oct. 18	Oct.	Oct.	Oct. 22	Oct.	Oct. 27	Oct. 18	Oct. 31	op do	Now 3	do	Nov 4	Nov. 14	Nov. 15	op	NOV. IV
Tumber	of neasure- ment		88	888	200	88	38	28	250	28	001	102	108	105	106	100	100	110	111	112	113	114	115

EXTRACT FROM THE REPORT OF MR. THOMAS RUSSELL, ASSISTANT ENGINEER, DETROIT, MICH., MARCH 24, 1903.

Chief of Engineers' Report, App. EEE, p. 4106.

"DESCRIPTION OF ST. CLAIR RIVER.

From Lake Huron to the Grand Trunk Railway gauge, a distance of 0.8 of a mile, the St. Clair River flows southwest. The river is comparatively narrow over the stretch, 1,015 feet wide on the average and 37.1 feet deep. The fall is 0.755 of a foot and the velocity relatively great.

From the Grand Trunk Railway gauge to Roberts Landing the river may be divided into eight well-marked stretches of nearly uniform width and depth.

From the Grand Trunk Railway gauge the river flows nearly southeast for 7,392 feet to the mouth of Black

nearly southeast for 7,392 feet to the mouth of Black River; the average width and depth are 1,498 feet and 31 feet, and the fall 0.554 of a foot.

From Black River to Dry Dock section, 14,300 feet, the river flows southwest; the average width is 2,167 feet and the depth 27.3: The fall is 0.375 of a foot.

At Dry Dock the river bends, flowing more nearly south, and for a distance of 17,952 feet to Marysville the average width is 2,078 feet and the depth 29.6 feet. The fall is 0.491 of a foot.

From Marysville to St. Clair the river flows nearly south for 30,096 feet. The average width is 3,002 feet and the depth 24.3 feet. The fall is 0.786 of a foot. In this stretch Stag Island divides the river into two channels for a distance of 11 miles.

From St. Clair to a point 20,000 feet below to (a) the river flows south, slightly toward the east, with an average width of 1,828 feet and a depth of 34.3 feet. The computed fall is 0.473 of a foot.

From the point (a) to Marine City the river flows a little west of south for 21,120 feet with an average width of 2,984 feet and a depth of 25.6 feet. The computed fall is 0.448 of a foot.

From Marine City to a point (b) 12,000 feet below, the river flows southwest with an average width of 3,135 feet and depth of 25.1 feet. The computed fall is 0.214 of a foot. In this stretch Woodtick or Fawn Island divides the river into two channels for a distance of one-half mile.

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From the point (b) to Roberts Landing, 10,032 feet, the river flows between south and southwest with an average width of 2,289 feet and a depth of 29.9 feet. This average width and depth includes 6,000 feet of the river below Roberts Landing. The computed fall is 0.197 of a foot.

The first distributary from the river is Chenal Ecarte, 7,000 feet below Roberts Landing. At Russell Island 16,000 feet below Roberts Landing, the river divides, going to Lake St. Clair through North Channel by Algonac and through South Channel to St. Clair Flats Canal.

The differences of level given above are for a height of Lake Huron of 580,479 feet at Sand Beach and depend on observations of water level made on six days in June, 1899, at ten-minute intervals, from 7 a.m. to 5:30 p.m.

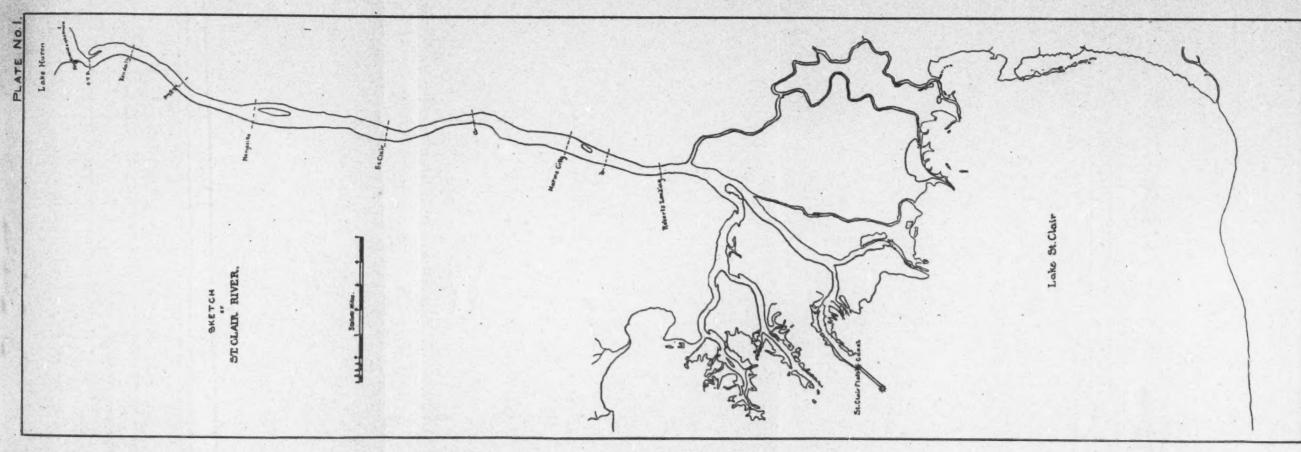
(Report of 1900, p. 5365.)

The height of river at Roberts Landing for the same time is derived as 576, 186, considering the level of river to fall uniformly from Marine City gauge, 21.8 miles below Fort Gratiot light-house, to the Algonac gauge 29.1 miles. The distance from light-house to Roberts Landing is 26 miles."

Report of Mr. Thomas Russell, Asst. Engineer, Detroit

Mich., March 24, 1903, page 2839.

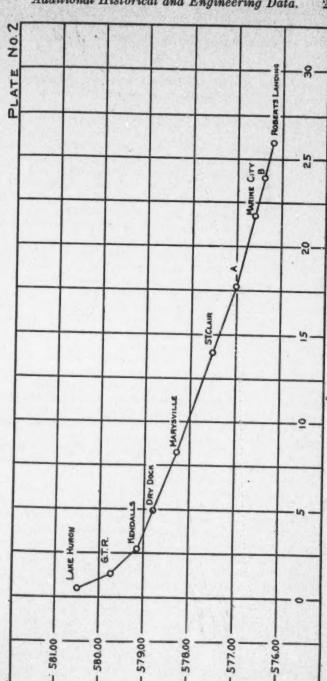
Opposite hereto are attached Plates 1 and 2, which appear in said report, opposite page 2841.



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SCALE





EXTRACT FROM REPORT OF THOMAS RUSSELL, ASSISTANT ENGINEER, DATED DETROIT, MICH., MAY 18, 1904:

"Effect of Ice on Discharge.

The differences, St. Clair minus Detroit, are often very great in the winter months. This is due to ice blockades in either the St. Clair or the Detroit Rivers. When the difference is plus, as in February, 1860, +125,100; March, 1877, +115,600; January, 1884, +95,700; February, 1886, +100,200; April, 1901, +87,500, it indicates that the blockade is in the St. Clair River. The discharge being diminished the level of Lake St. Clair falls. The gauge readings for St. Clair Flats Canal and Cleveland give the true discharge of the Detroit River, which must be the same as the water actually passing through the St. Clair River. The gauges at Sand Beach and St. Clair Flats Canal do not give the true discharge of the St. Clair River when blocked with ice. The effect of the great blockade of 1901, extending into May, is visible in these differences.

The effect of an ice bockade in the Detroit River is to cut down the discharge. This increases the height of Lake St. Clair, which checks the flow from the St. Clair River. The computed discharge of the Detroit River under these circumstances is greater than the true discharge, and the differences, St. Clair minus Detroit, are largely minus. The largest cases of this kind are: February, 1857,—102,700; March, 1876,—37,300; March, 1885,—52,800; January, 1895,—56,400; February, 1895,—

59,700; February, 1897,—45,200.

Sometimes when there is no blocking by ice St. Clair minus Detroit gives minus differences which are large. These may be due to heavy rains over the drainage area of Lake St. Clair. Ossasionally there is a summer month with St. Clair minus Detroit a small plus value, indicat-

ing great evaporation from Lake St. Clair.

In the case of ice blockades the difference of the tworivers given in Table XII is not the true amount of water held back. For ice in the St. Clair River the Detroit River gives the true discharge, but on account of the lowering of Lake St. Clair the computed discharge of the St. Clair River is too great. A better difference for comparative purposes is the normal discharge pertaining to the height of Lake Huron, and the normal height for Lake St. Clair computed from Lakes Huron and Erie by for-

mula (23).

When there are ice blockades in both rivers the true discharges are not given by either formula and the differences are not significant. With ice in the rivers the formulae always give results more or less inaccurate. A complete covering of ice a foot thick, such as may often occur, diminishes the cross section of river and gives a computed discharge too great in the case of both rivers by about 10,000 cubic feet per second. The velocity of water under the ice is reduced by friction, and the discharge thereby also diminished. For the St. Marys River, where observations of discharge were made under ice, the diminution of average velocity of water due to ice covering was about one-thirtieth of the whole. (See Report of Chief of Engineers, 1897, p. 4092.)

The ice effects shown by the differences in Table XII for the winter months are mainly due to gorges at the St. Clair Flats or higher up on the middle grounds at Marine City and St. Clair. The level of the river along the stretches above the gorge rises sometimes up to the level of Lake Huron at Fort Gratiot lighthouse.

Observations of the discharge of St. Clair River were made during one of these gorges. Results of these measurements are given in report for 1902, page 2837. In that report the diminished discharge is related by an empirical formula to the decreased slope of river between Grand Trunk Railway and Dry Dock gauges, or between Grand Trunk Railway and Mouth of Black River gauges. normal difference between Grand Trunk Railway and Dry Dock is 0.84 foot. In ice blockades this difference may diminish to 0.10 foot. For the great blockade of 1901 the discharge of the St. Clair River is shown below as given in the 1902 report derived from the fall at the head of St. Clair River, or measured, and the discharge of Detroit River as given in Table XII, with 4,700 subtracted, which is, presumably, the true value of the discharge of St. Clair River. The discharge of the St. Clair River, as it would have been, was derived by means of the formula for discharge using the elevation of Lake St. Clair as derived from Lakes Huron and Erie by formula (23).

Ice Effect.

St. Clair River Monthly Mean Discharges in Cubic Feet Per Second.

	From repo	rt of 1902	As determined in this report.					
	Computed discharge.	Ice Effect.	Discharge derived from Detroit River.	Ice Effect.				
1901 January February March April May	160,300 102,200 133,900 130,500 189,000	30,300 85,900 53,800 66,300 11,800	185,300 160,300 173,700 138,200 185,300	8,070 34,070 18,970 56,770 16,770				

The method of deriving the quantity of water held back by an ice gorge, as given in 1902 report, dependent on the relation between the restricted discharge and the slope at head of river as observed in some particular year, is not a method strictly applicable for other years unless the ice obstruction is located in the same part of river. The relation of slope to discharge must depend on the location of the obstruction. For this reason it is believed the computed discharge of the Detroit River is a better measure of the quantity of water passing through the St. Clair River during ice gorges than any derivation based on slopes over short stretches of the river. determination by Detroit River is by no means certain. When there is a gorge in the Detroit River the gauge readings give an erroneous result for discharge. Ice gorges in the Detroit River. however, are less frequent than in the St. Clair River."

Chief of Engineers Report, 1904, App. EEE, pages

4106 and 4107.

page 4115.

"CHANGE IN REGIMEN OF ST. CLAIR RIVER.

The differences in the St. Clair and Detroit River changes of discharge may be due either to errors in the discharge formulae or in the gauge readings. Systematic errors of such extent in the gauge readings as to account

for the differences are not very likely and may be left out of consideration.

In the discharge formulae the error may occur in two ways, either in the coefficients of the formulae or in the datum discharge. In the formula for St. Clair River,

D(St. Clair)=Do+AH+Bh

the datum discharge Do may be different at different times if there are considerable changes in the river. If a layer of 1 foot in thickness was scoured off the bottom of the river while the surface remained at the same elevation the cross-section of river would be increased and the datum discharge increased by about 15,000 cubic feet per second. If then it be granted that the bottom of the river is lower in later years than formerly, the discharge formula determined from observations in recent years would give a discharge for the earlier years too great by the amount of the error in the datum discharge. That there may have been such a change in the river is possible, for the beds of rivers are continually wearing away by erosion. With the greater velocities accompanying high stages, the cutting is presumably more rapid at high stages than at low stages of water. The swift current in the narrow rapids from Fort Gratiot lighthouse to G. T. R. gauge is an especially favorable place for this kind of The bottom of the St. Clair River is subject to very great changes during ice blockades, the grounded ice plowing up the bottom and the concentrated currents at constricted places cutting away soft material very rapidly. When the ice blockade is lifted it causes temporary steep slopes along the lower stretches of river with velocities of great cutting effect. After the great ice blockade of 1901 the swift current through St. Clair Flats Canal caused a deepening of several feet at places in the lower end of the canal.

The delta of St. Clair River, the St. Clair Flats, is no doubt composed in part of material carried away from the banks and bottom of St. Clair River and deposited in that region. While some of the delta consists of this material, the greater part, however, is material from Lake Huron, which, shifting along the shore under the action of waves and currents due to storms in passing across the entrance to St. Clair River, is carried down by the current. The water of Lake Huron at entrance to St.

Clair River contains very little solid matter in suspension, except during storms. There is some silt carried into St. Clair River by its tributaries, the Black, the Pine.

and the Belle rivers.

The cutting of the river in the upper part where the current is strong tends to deepen it and increase the discharge. This is in a measure counteracted by the deposition of the material in the slack currents of the channels and shoal parts of the flats, which tends to raise the bottom and diminish the discharge. This deposition is going on over a great part of the area below the first distributary, the Chenal Ecarte, which leaves the St. Clair River a mile and a half below Roberts Landing.

In the shallow stretches of the river the propeller wheels of steamers stir up the material of the bottom, which tends to deepen the channel and increase the discharge. From the head of Russel Island to St. Clair Flats Canal, a distance of 10-1/2 miles, the depth of channel only exceeds by a few feet the draft of the largest steamers passing. In the last ten years the draft of vessels passing has increased a good deal. The number of vessels, moreover, now passing is greater than formerly. In the season of navigation there are 33,000 vessel passages through Detroit and St. Clair rivers. This may have had some effect in making the present discharge of river greater than it was in former years. (See Report

of Chief of Engineers 1903, p. 2040.)

Changes in Detroit River to explain the differences in discharge between it and St. Clair River would require to be from a greater discharge to a less, and this is very The changes in Detroit River are very improbable. likely to be in the same direction as in the St. Clair, but much less in amount. The Detroit River at the upper end near Lake St. Clair has a large cross-section and very little slope and the velocity of water is small. the lower end of the river near Limekiln Crossing where the slope is steep and the velocity of water great, at times of low water in Lake Erie, the bottom is not subject to much erosion on account of it being a limestone ledge. There has been, in recent years, considerable excavation of the bottom rock in this region in widening the channel and deepening it to 21 feet. This may have affected the discharge of the Detroit River, but probably only slightly. The river at Limekiln Crossing is a mile and a half wide and the deepening of a part 600 feet wide

by a few feet would have only a relatively small effect on the cross-section.

The building of docks on the river front of the city of Detroit has diminished the width and cross-section of the river along a stretch of about 4 miles and must have changed considerably the relation of discharge to stage for the present time as compared with what it was many years ago. Very little change, however, can be due to this cause in recent years, since 1892.

The railroad bridge at Trenton Crossing, over the channel west of Grosse Isle and from Grosse Isle to Stony Island and the pier extending from Stony Island 1,300 feet into the main channel of Detroit River, must have had some effect on the relation of discharge to stage. This bridge was built in 1872.

St. CLAIR RIVER AND NIAGARA RIVER DISCHARGE,

A comparison of the outflow from Lake Erie through the Niagara River with the discharge of the St. Clair River for the ten years 1883-1892, June to November, shows that the computed discharge of the St. Clair River for that time is probably too large.

The six months' means of gauge readings, June to November, for Breakwater lighthouse gauge at Buffalo, the corresponding means at Cleveland, and the differences are as follows, levels of 1903:

Year.	Cleveland.	Buffalo.	Cleveland minus Buffalo.
	Feet.	Feet.	Feet
1887	573.31	573.44	-0.13
1888	572.83	572.96	13
1889	572.53	572.68	15
1890	573.22	573.33	11
1891	572.03	572.22	19
1892	572.73	572.93	20
1893	572.40	572.70	30
1894	572.25	572.50	25
1895	571.20	571.42	22
1896	571.67	571.79	12
1897	572.20	572.27	07
1898	572.22	572.38	16
1899	572.17	572.00	+ .17
1900	572.06	572.12	06
1901	571.60	571.66	06
1902	572.38	572.37	+ .01
1903	572.57	572,56	+ .01
	2.00		
Mean			12

The mean gauge reading at Buffalo, June to November, 1883 to 1892, is 573.24. The discharge of the Niagara River (Report of 1900, p. 5361) is 222,400 cubic feet per second for 573.15, new levels, by Breakwater gauge at Buffalo. The discharge for Niagara River for 573.24 is 224,490 cubic feet per second. The increase in discharge of Niagara River for 1 foot rise is 23,205 cubic feet per second, the mean of values given for open section and bridge section.

The discharge of Niagara River should have 1,200 cubic feet per second added for the flow through the Eric Canal and 1,100 cubic feet per second for the flow through the Welland Canal. This gives the outflow from Lake Eric 226,790 cubic feet per second. In Report for 1903, page 2858, the amount for Welland Canal is estimated by the department of railways and canals of Canada: for the Eric Canal as estimated by the New York engineer for water supply.

The average discharge of St. Clair River, June to November, 1883 to 1892, is 223,338 cubic feet per second by

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formula (20). Adding to this 4,700 for the water added by the drainage area of Lake St. Clair, the water entering Lake Erie from the Detroit River is 228,038 cubic feet per second.

The mean of the monthly means of gauge readings for May and June gives the gauge reading for the epoch of June 1. The mean of monthly means of gauge readings for November and December gives the gauge reading for epoch of December 1. The difference between the reading of gauge on June 1 and on December 1 shows the depth by which the lake has increased or decreased.

In Table XVI are given the means of gauge readings, June to November, 1883-1892, by which the discharges of St. Clair River are computed and the differences of level of Lake Erie between June 1 and December 1 determined.

TABLE XVI.—MEAN GAUGE READINGS, JUNE TO NOVEMBER, LAKES HURON, ST. CLAIR AND ERIE, AND HEIGHTS OF ERIE ON JUNE 1 AND DECEMBER 1—LEVELS OF 1903.

	Sand Beach,	St. Clair Flats,	Cleve- land,	Gaug	ge at Cleve	eland.
Year	mean, June- Nov.	mean, June- Nov.	mean, June- Nov.	June 1	Dec. 1	Differ- ence
	Feet	Feet	Feet	Feet	Feet	Feet
1883	583.00	577.15	573.76	573.61	573.11	-0.50
1884	582.85	576.86	573.45	574.10	572.49	-1.61
1885	583.17	576.91	573.83	573.72	573.55	17
1886	583.23	576.78	573.51	573.86	572.88	98
1887	582.49	576.42	573.31	574.06	572.44	-1.62
1888	582.07	575.98	572.83	573.05	572.35	70
1889	581.46	- 575.65	572.53	572.73	571.89	84
1890	581.44	575.92	573.22	573.80	572.65	-1.15
1891	580.60	575.06	572.03	572.51	571.25	-1.26
1892	580.75	575.46	572.73	572.37	571.69	68
Mean	582.11	576.22	573.12			98

Denoting the quantity of water in Lake Erie on June 1 by W, the number of seconds from June 1 to December 1 by t, the average number of cubic feet per second of water added to Lake Erie by the rainfall over its drainage area from June 1 to December 1 by x, and the number of cubic feet per second evaporated from the surface of the lake by y, then the quantity of water in Lake Erie on June 1, plus the amount added by the St. Clair River and the Lake St. Clair drainage area, plus the

amount added from the drainage area of Lake Erie, minus the amount evaporated from the surface, minus the amount taken out through the Niagara River and the Welland and Erie canals, must be equal to the quantity of water in the lake on December 1, which is also equal to the quantity in the lake on June 1, minus a layer of water equal to the fall in the surface of the lake from June 1 to December 1.

The average fall of the lake from June 1 to December 1 for 1883-1892, as shown by Table XVI, is 0.95 foot; this is equivalent to 16,975 cubic feet of water per second from June 1 to December 1. The area of Lake Erie is

9,968 square miles.

W+(228038)t-(x)t-(y)t-(226790)t=W-(16975)t (28) Cancelling the W and dividing by t this becomes y=x+18223,

which means that the evaporation from the surface of Lake Erie is equal to the entire amount of water supplied to the lake by its drainage area of 34,573 square miles, and, in addition, 18,223 cubic feet per second. The total outflow from the lakes through Niagara River is 222,400 cubic feet per second, and the drainage area of the lake region above Niagara River is 254,708 square miles. Taking the water furnished to Lake Erie by its drainage area as proportional to the area, the quantity is 30,100 cubic feet per second. This would make the evaporation from the surface of the lake 48,323 cubic feet per second from June 1 to December 1, which is 0.451 foot per month, or 32.4 inches from June 1 to December 1, an amount which seems too great.

COEFFICIENTS OF DISCHARGE FORMULAE.

The large differences in the monthly discharges of the St. Clair and Detroit rivers, computed from the monthly mean gauge readings, may be due in part to error in the coefficients of the formulae as well as in the datum discharges for the St. Clair and Detroit rivers. An examination of Table XV bears out this view to some extent as the differences, St. Clair minus Detroit, have a tendency to be greater the higher the stage of Lake Huron. In 1836, for example, Lake Huron was 2.53 feet above datum stage, the highest for any season, and the differences.

y

n

d

ence of discharge, St. Clair River minus Detroit River plus 26,600 cubic feet per second, is also the greatest.

The theoretical values of A and B for St. Clair River are +29500 and -16390, while the values from discharge observations are +35145 and -20928. Even if the theoretical values of the coefficients were used in computing the dicharges, the difference for 1886 would be diminished only 5,200 cubic feet per second. As long as the coefficients A and B change by the same amount, it makes very little difference in the discharges, unless the slope of river changes. The absolute magnitude of A and B, then, has little effect in changing the computed discharge. The difference of the coefficients A and B, which is the change in discharge for 1 foot rise in the river, is well determined by the discharge observations. The datum discharge may be in error by a considerable amount on account of unavoidable errors in determining the cross-section of river at the discharge section, as this depends on soundings made on the crosssection, which may be two or three-tenths of a foot or even more in error. The observed change in discharge from datum stage to other stages, which determines the coefficients A and B, is not affected with much error, as the determination of change in cross-section for increase in height of water depends on gauge readings of the height of river surface, which are made accurately to the hundredth of a foot.

In the case of the Detroit River, the theoretical values of the coefficients A' and B', +43940 and -32340, differ a good deal from the values found from the observation equations, +37483 and -21784. No great stress, however, is laid on the accuracy of the theoretical values. The flow of water in the Detroit River, through the many channels of varying width and depth, is too complicated to admit of very satisfactory theoretical treatment. The determination of the coefficients A' and B' for the Detroit River from the discharge observations are not as accurate as for the St. Clair River, as the rapid changes of water level at Amherstburg interfere to some extent with the precise determination, and the observations do not cover much range in stage between Windmill Point and Amherstburg. The difference of the coefficients for Detroit River is, however, fairly well determined. The variations in slope of the Detroit River, in the monthly means, are not as great as in the case of the St. Clair River. Any errors that there may be in the absolute values of A' and B' have therefore only a slight effect on the computed changes in discharge. Errors even as great as 4,000 in the values, provided they are the same in both coefficients, would make very little difference in the computed discharges.

It would seem, then, that a great part of the difference in discharges between the St. Clair and Detroit rivers, computed from the monthly means of gauge readings for past years, might properly be attributed to changes in the datum discharge of the St. Clair River, indicating a greater height of the river bed in former years than at

the present time.

For the ten years, June to November, 1873-1882, the difference is +10530 cubic feet per second. For the ten years 1883-1892 the difference is +12180 cubic feet per second. For the eleven years 1893-1903 the mean difference is -300, being -8500 for 1896 and +4000 for 1897. The mean of the twenty years 1873-1892 indicates an increase of 11,355 cubic feet per second in the datum discharge of St. Clair River. The change in discharge for 1 foot rise of the surface of river is 14,217 cubic feet per second. A lowering of the bed of river by about 0.8 foot is therefore indicated since 1893, as compared with the twenty years preceding.

A change in the datum discharge of the St. Clair River, through a lowering of the bed of the river, would cause a lowering of the level of Lake Huron by the same amount and a rise in level of Lake Erie for the time being. The level of Lake Erie, however, after equilibrium was restored and the surplus water had run off, would be the same as before, provided there were no change in the bed

of Niagara River.

If there has been a lowering of the level of Lake Huron since 1892 due to scour of the St. Clair River, it would seem that a comparison of the levels of Lakes Huron and Erie before and since that time should show it. No satisfactory comparison of this kind, however, can be made, as the water supply to the lakes from rainfall differs so much in different years and is so variable over different parts of the drainage area. Besides this, the ice blockades in the St. Clair River have such a variable effect in storing water in Lake Huron in winter time and raising the level of the lake that any lowering of level due to scour can not be certainly distinguished.

The differences in the discharges of St. Clair and Detroit rivers for years preceding 1873, June to November, are as follows, in units of 100 cubic feet per second:

are as romons	ALL WALLOS	of too capic reet ber secon	MALE O
Year	CI. CIR A	Year	St. Clair minus
1	Detroit		Detroit
1855	. +20	1864	61
1856		1865	-54
1857		1866	-179
1858		1867	-89
1859		1868	-143
1860		1869	-37
1861		1870	75
1862		1871	20
1863		1872	+100
FF77 71 3		1 1 1050 3	3

The discharges for years previous to 1872 depend on values for St. Clair Flats Canal gauge heights, derived from observations of river surface at Detroit waterworks, foot of Orleans street. The old levels at waterworks show many discordances and are probably in some cases largely in error. No great stress, therefore, can be put on these differences as showing changes of regimen in the St. Clair or Detroit rivers."

Chief of Engineers Report, 1904, Appendix EEE, pages

4115-4119.

"RAINFALL, EVAPORATION AND RUN-OFF.

page 4120.

For the sixteen years 1883 to 1898, the rainfall observations of the United States Weather Bureau in the region of the Great Lakes have been collated for the drainage areas of the various lakes, and this makes it possible, with the discharges through the connecting rivers and with the levels of the lakes, to form some idea of the evaporation from the lake surfaces and the fractional part of the rainfall on the land part of the drainage areas that run into the lakes. The rainfalls for Lakes Superior, Michigan-Huron, and St. Clair-Erie are given in report for 1903, page 2872. In Tables XVII and XVIII the rainfall for Lakes St. Clair and Erie are given.

Curves showing the mean monthly elevations of Lake Superior, Michigan-Huron, and Erie for 1883-1898 are given in sketches Nos. 3, 4 and 5. The mean monthly rainfalls over the drainage areas for same period are

also shown on the sketches.

TABLE XVII-LAKE ST. CLAIR DRAINAGE AREA-MONTHLY RAINFALL, IN INCHES.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
882		******					a1.40	85.58	al. 42	2.22	1.86		
383.			1.90	1.66	5.28		6.17	1.21	2.13	3.00	2.69		
384			2.76	1.75	2.14		3.78	1.87	2.40	800	1.90		
386				2.87	3.32		2.87	4.53	2.43	2.97	3.18		
980	3.36	2.03	2.66	2.63	2.87	2.13	2.34	2.87	2.50	1.50	2.87	2.91	32.77
7867				1.29	2.00		1.21	1.79	2.73	2.28	2.08		
				1.82	2.29		2.70	1.65	1.65	2.85	2.99		
				1.79	4.41		1.73	.86	1.65	1.10	3.23		-
300.				2.70	4.73		1.52	3.68	1.99	5.30	2.99		
301				2.13	1.76		3.02	3.89	2.68	2.16	5.34		
392				1.61	5.68		2.15	2.47	4.62	1.18	3.16		
393.				3.71	2.47		2.21	1.61	1.45	4.20	3.33		
394.				2.24	. 7.01		.86	90	3.50	2.47	1.42		
395.				1.45	2.50		2.20	2.57	2.91	.53	4.07		
386		1.89		2.83	2.81		3.31	4.49	4.52	1.60	2.16		
207		1.46		2.06	3.99	2.58	3.86	2.69	.79	1.40	4.58		
		2.54		1.58	2.03		1.55	1.57	2.93				100
Mean (16 years)	2.42	2.41	2.02	2.10	3 48	2 19	9 KO	9.34	9 88	9 49	00 6	9 49	

a Not used in mean, July, August and September, 1882.

TABLE XVIII-LAKE ERIE DRAINAGE AREA-MONTHLY RAINFALL, IN INCHES.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
1889							a2.49	83.95	a2.21	2.20	2.69	2.28	
1000	1 68	3 07	1 36	2 10	8.17	4.86	4.94	2.17	2.65	3.24	3.06	2.40	-
1004	2 98	4 03	9.58	1.46	2 83	2.59	200	1.87	2.37	2.21	1.97	2.77	
100K	2.73	1 31	98	2 69	4 02	4 86	2.89	5.49	2.58	3.94	3.21	2.44	
1000k	3 30	1 91	2.50	2.61	2.81	2.53	1.83	2.99	4.44	1.49	3.93	3.16	
1007	1 80	8 44	201	1.80	2.58	3.13	1.47	2.42	2.71	2.25	3.31	2.82	
1888	2.65	1 81	2 98	2 33	2 94	3.43	2.94	2.72	2.32	2.86	3.57	1.89	
1000	00.0	1 67	1 70	2 22	4 53	3 54	28	1 21	2.98	1.50	3.44	3.40	
1900A	4 13	30.00	3 10	3.42	5.44	3.93	1.36	3.40	3.75	4.81	2.98	1.43	41.03
1901	2 20	4.39	3 21	2.00	1.59	3.07	2.72	3.07	1.83	2.05	5.59	2.23	
1902	2 20	2 81	2.59	2.72	8 28	6.07	3.66	2.95	8.28	1.00	3.07	1.65	
1902	2.72	4 75	2 21	4.93	4.40	2.72	2.46	2.15	1.50	3.72	3.13	3.16	*
1904	20.00	2.78	1 80	2.04	5.28	2.75	1.77	.78	4.10	3.34	1.96	2.37	
180K	3 11	75	1.41	1.70	2.24	1.62	2.07	2.78	2.21	1.40	4.72	4.63	
1808	1 70	9.72	2.70	3 01	2.53	3.79	5.98	3.37	4.50	1.30	2.57	1.76	
1007	2 63	1 70	3 60	2 68	3.80	2.80	4.07	2.84	.78	1.18	5.40	2.00	
1898.	38.88	2.48	4.23	1.92	3.42	2.89	3.25	3.15	3.38		* * * *		
Mean 16 years	2.64	2.93	2.44	2.48	3.93	3.41	2.88	2.71	2.84	2.42	3.41	2.53	:::::::::::::::::::::::::::::::::::::::

a Not used in mean, July, August and September, 1882.

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These mean values of rainfall include not only the observations at all the regular Weather Bureau stations, but also numerous observations made by voluntary observers under the direction of the Weather Bureau scattered over the area and the stations of the weather service of the Dominion of Canada. The voluntary observations begin about 1883.

LAKE SUPERIOR-EVAPORATION AND RUN-OFF.

In discussing the evaporation and run-off the average annual oscillation of the level of the lake for sixteen years,

1883-1898, will be used.

The level of the lake presents in the average for the sixteen years one large wave with the period of a year. The difference between the lowest level, that of April 1, 601.11 feet, and the highest, that of August 1 and of September 1, 602.20 feet, is 1.09 feet.

The mean monthly elevations and the elevations of the lake on the 1st day of each month are shown in Table

XIX, and also the mean rainfall for sixteen years.

Table XIX—Lake Superior—New Levels—Monthly Means of Gauge Readings, and Gauge Readings on 1st of Month of Upper Gauge, Saulte Ste. Marie, for Sixteen years, 1883 to 1898.

Month	Means of months.	Stage on 1st of month.	Rainfall
	Feet.	Feet.	Inches
January	601.34	601.49	1.60
February	601.15	601.24	1.35
March	601.08	601.12	1.33
April	601.14	601.11	1.90
May	601.60	601.37	2.54
June	601.96	601.78	2.72
July	602.17	602.06	3.08
August	602.24	602.20	2.70
September	602.16	602,20	2.73
October	602.11	602.14	2.62
November	601.95	602.03	1.97
December	601.64	601.80	1.73

Taking the year in two parts of six months each from March 1, near the time of minimum level of the lake, to September 1, near the time of maximum level, the rainfall for the first period is 15.67 inches, equal to 1.31 foot, and for the second period 10.60 inches, equal to 0.88 foot. The area of Lake Superior drainage area is 76,134 square miles, and that of the lake itself 32,060 square miles. The ratio of land to water surface is 1.37. The mean discharge of the St. Marys River, adopting the results given in 1903 report, page 2873, is 69,540 cubic feet per second for the first period and 70,250 cubic feet per second for the second. A discharge of 57,460 cubic feet per second for six months is equal to a depth of water of 1 foot over the whole surface of the lake. The discharge for the first period is then equal to 1.21 feet on the lake, and for the second period 1.22 feet.

Denoting by x' the part of rainfall on the land area that runs into the lake, and by E' the evaporation from the lake surface for the first period, then the fractional part of rainfall on the land, plus the rainfall on the lake, minus the evaporation, minus the discharge of the St. Marys River, is equal to the rise in the level of the lake.

$$1.78x'+1.31-E'-1.21=+1.09...$$
 (33)

for the second period, in the same way, x'' being the fractional part of land rainfall running into the lake and E'' the evaporation, the equation is obtained—

$$1.21x'' + 0.88 - E'' - 1.22 = -1.09 \dots (34)$$

For the whole year the equation is:

$$2.99x + 2.19 - E - 2.43 = 0 \dots (35)$$

Equation (34) shows that to make the evaporation of the winter part of the year small very little of the winter precipitation should go into the lake. Making x'' zero gives the evaporation for the winter period 0.75 feet, or 9 inches. It would be more if there was much water running into the lake from ground storage. The temperature of the water in the lake is higher than that of the air, and the winds are very strong. Evaporation increases greatly with the strength of the wind. As regards the run-off for the winter period in the Lake Superior

region, it is likely that very little of what falls on the land goes into the lake.

There are numerous lakes in the area, some of considerable size, as Lake Nipigon, with 1,730 square miles of surface.

If the evaporation from the lake in the winter period is 0.75 foot the evaporation from the land in the snow months must be large. It would probably not be quite so great in forest areas as on the open lake, the snow being shaded from the sun and sheltered from the wind. The total fall on the land is only 0.88 foot, which indicates very little supplied to the lake from melting snow. The total fall for the snow months, December to March is 6.01 inches melted snow, and it would seem, therefore, the greater part of that must evaporate and very little reach the lake.

Regarding the evaporation for the summer part of the year, it would seem that it ought to be greater than for the winter part, but in equation (33) to produce this result would require that all or nearly all of the land rainfall should go into the lake. Taking x'=1 gives E'=0.78 foot, and the evaporation must certainly be less than this. The whole evaporation from Lake Superior for a year is then probably less than 1.53 feet, or less than 18

inches.

As a matter of fact a greater part of every rainfall except winter snow, sinks into the ground or is stored in the smaller lakes and runs out gradually throughout the whole year.

Adopting 1.53 feet as the evaporation from the lake, equation (35) gives x equals 0.6, or the run-off from the land surface of Lake Superior drainage basin is 0.6 of the rainfall on the land surface for the entire year.

The levels of Lake Superior given are by the gauge on St. Marys River above the locks at the entrance to the canal, Sault Ste. Marie, Mich. The level of water here is 0.202 foot, on the average, lower than the level of the lake at Iroquois Point, 13.5 miles above. Sometimes the difference is as small as 0.089 foot and sometimes as great as 0.611. (Report of Chief of Engineers, 1902, p. 2210.) In winter the river is covered with ice from early in January to the middle of April; when at its greatest it is 2 feet thick and extends to about 1,000 feet above the International Bridge, where the open water of the rapids be-

gins. When the ice forms the discharge of the river is diminished and the slope is increased, which causes some fall at the lock gauge for which there is no corresponding fall in the surface of Lake Superior. The oscillation of the lake is then really less than 1.09 feet by some hundredths of a foot, and possibly by even as much as one-tenth of a foot.

LAKES MICHIGAN-HURON-EVAPORATION AND RUN-OFF.

In Table XX are shown the means of the mean monthly heights of level of Lake Huron at Sand Beach for the sixteen years 1883-1898, the heights on the 1st day of month derived from these means, and the means of the monthly rainfalls for the sixteen years.

Table XX—Lake Huron—New Levels—Monthly Means of Gauge Readings and Readings on First of Month of Sand Beach Gauge, For Sixteen Years, 1883 to 1898.

Month	Means of months.	Stage on 1st of month.	Rainfall.
	Feet.	Feet.	Inches.
January	580.88	580.86	2.90
February	580.84	580.86	2.23
March	580.91	580.87	2.01
April	581.09	581.00	2.19
May	581.42	581.25	3.04
June	581.69	581.55	3.08
July	581.79	581.74	2.68
August	581.74	581.77	2.75
September	581.52	581.63	2.94
October	581.28	581.40	2.66
November	581.05	581.17	2.89
December	580.83	580.94	2.75

The range in the level of the lake from February 1, 580.86 to August 1, 581.77, is 0.91 foot. The drainage area of Lake Michigan-Huron is 137,807 square miles; the area of lake surface is 45,314 square miles; the land surface is therefore 2.04 times the water surface.

The rainfall from February 1 to August 1 is 15.23 inches, equal to 1.27 feet; from August 1 to February 1 it is 16.89 inches, equal to 1.41 feet. Lake Huron receives from the St. Marys River, February 1 to August 1, 66,300 cubic feet of water per second, and discharges through the St. Clair River 198,190 cubic feet per second. The discharge of the Detroit River with 4,700 subtracted is adopted as the discharge of the St. Clair River on account of the winter month discharges computed from gauge readings being erroneous at times due to the effect of ice blockades. This equation is then obtained for February 1 to August 1:

$$2.59x'+1.27-E'-0.82-2.44=+0.91...$$
 (36)

From August 1 to February 1, 73,520 cubic feet per second is received from the St. Marys River and 200,850 cubic feet per second discharged through the St. Clair River. For August 1 to February 1, then, the equation is:

$$2.88x'' + 1.41 - E'' + 0.91 - 2.47 = -0.91 \dots (37)$$

For the year the equation is:

$$5.47x + 268 - E + 1.73 - 4.91 = 0 \dots (38)$$

Adopting six-tenths of the rainfall for the year on the land surface as the run-off from the land into the lake, the evaporation from the lake for the year is 2.76 feet or 33 inches. Equations (36) and (37) show that taking the evaporation for the two parts of the year nearly equal, the summer vun-off from the land is a large part of the land rainfall and the winter run-off a small part of the winter rainfall, indicating storage in ground or small lakes and a gradual discharge into the lake in the summer time.

TABLE XXI. LAKE ERIE—MEAN MONTHLY ELEVATIONS AND RAINFALL, 1883-1899—ERIE REDUCED FOR VARIATIONS IN LEVEL OF LAKE HURON.

			Elev	Elevations of water	r surface, Lake Erie	Erie.	
MONTH	Iake Huron at Sand Beach	Change (+Rise -Fall)	Observed	Derived from Lake Huron	Corrected for changes in Lake Huron	Mean on first of Month Corrected	Rainfall
	Feet	Feet	Feet	Feet	Feet	Feet	Inches
DUSTY	580.88	+0.06	572.00	572.38	572.10	572.07	2.6
bruary	580.84	3	571.97	572.32	572.13	572.12	2.93
arch	580.91	4 .07	572.11	572.28	572.31	572.22	2.44
April	581.00	+ 18	572.50	572.30	572.68	572.50	2.48
M	581.42	+ 33	572.92	572.37	573.03	572.86	3.93
9	581.69	12. +	573.18	572.48	573.18	573.10	3.41
>	581.79	+ 10	573.11	572.59	573.00	573.09	2.90
enset.	581 74	198	572.91	572.66	572.73	572.87	2.71
ptember	581.52	1 22	572.63	572.67	572.44	572.58	2.84
toher	KR1 28	12	572.34	572.64	572.18	572.31	2.43
nyambar	581 06	8	572.04	572.56	571.96	572.07	3.41
December.	580.83	1 23	572.01	572.46	572.08	572.00	2.53
Means			572.48	572.48	572.48		2.80

LAKE ERIE EVAPORATION AND RUN-OFF.

In Table XXI is shown for sixteen years, 1883-1898, the mean monthly levels of Lake Huron, the mean level of Lake Erie at Cleveland, the level of Lake Erie due to changes in Lake Huron, the level of Lake Erie corrected for changes in Lake Huron, the mean heights of Lake Erie on the first day of the month and the mean

rainfall for the months.

The level of Lake Erie due to varying level of Lake Huron was derived as follows: For a rise of 1 foot in Lake Huron equation (30) gives Lake Erie gaining water from Detroit River at the rate of (22553—7805y) cubic feet per second, where y is the rise in Lake Erie produced eventually by a rise of 1 foot in Lake Huron. Lake Erie loses water through Niagara River at the rate of 23205y cubic feet per second. The gain to Lake Erie is the difference of the two or (22553—31010y) cubic feet per second. In formula (25) then for the time t

$$t = \frac{F}{b} \log \left(1 + \frac{b}{a}y\right)$$

a=22553 and b=-31010

The rise y eventually produced in Lake Erie is 22553

= 0.727 foot. Substituting in the equation in

succession for t the number of seconds in one month, two months, etc., to seven months, the fractional parts of the rise occurring at the end of one month, two months, etc., to seven months are obtained. The differences of these numbers are the parts of rise occurring in the successive months. These differences multiplied by 0.727 give the rises in Lake Erie during the successive months due to a 1-foot rise in Lake Huron. The phases of the rise in Lake Erie being independent of the magnitude of the rise in Lake Huron, these factors multiplied by the actual monthly rises in Lake Huron give the actual rises in Lake Erie in successive months due to the rises in Lake Huron for one month, two months, etc., to seven months preceding. These parts of rise and factors are shown below.

MONTHS.	Part of rise in Erie at end of month. Foot.	Part of rise in Erie during month. Foot.	Erie rise during month for 1 foot rise in Huron. Foot.
First	0.251	0.251	0.182
Second	.439	.188	.137
Third	.580	.141	.103
Fourth	.685	.105	.076
Fifth	.763	.078	.057
Sixth	.823	.060	.044
Seventh	.868	.045	.033

The rise occurring in Lake Erie in any month is, then, 0.182 times the rise in Lake Huron for the month preceding plus 0.137 times the rise the second month preceding, etc., to plus 0.033 times the rise the seventh month preceding. The sum of rises in successive months gives the total rise.

In sketch No. 5 the curve of level of Lake Erie derived in this way is shown by broken line, the curve of actual level is shown by full line, the curve of level corrected for variation of Lake Huron by dotted lines, and the

mean monthly rainfall by heavy line.

The maximum stage for Lake Erie corrected is 573.10 on June 1, and the minimum stage 572.00 on December 1, a fall of 1.10 feet. The fall of the uncorrected surface of Lake Erie, 1.02 in the same time, is not very different. The drainage area of Lake Erie is 34,573 square miles, and the area of the lake 9,968 square miles. land area is 2.47 times the water area. The rainfall from June 1 to December 1 is 17.78 inches, or 1.48 feet; from December 1 to June 1 it is 16.94 inches or 1.41 feet.

The discharge of Detroit River for eleven years, 1893-1903, is, on the average, 193,854 cubic feet per second, The discharge of Niagara River for the same time is 197,328 cubic feet per second. The discharge of Niagara River should be 30,100 cubic feet per second greater than the discharge of Detroit River. It would require a very great and totally inadmissible evaporation from the lake to have the difference in discharges as small as the observations indicate. The most that can be done, then, with the water heights, discharge, and rainfall is to see what a reasonable value of the land run-off and the lake evaporation will give for the difference in the discharges of Detroit and Niagara rivers.

Denoting by x' the fractional part of rainfall on land that runs into the lake for the part of the year, June 1 to December 1, by E' the evaporation, and by d' the excess of discharge of Niagara River over Detroit River, expressed in heights taken off the lake surface by the excess of discharge, then for June 1 to December 1,

$$3.66x'+1.48-E'-d'=-1.10.$$
 (39)
and for December 1 to June 1,
 $3.48x''+1.41-E''-d''=+1.10.$ (40)
and for the year,
 $7.14x+2.89-E-d=0.$ (41)

Taking the run-off for the year as 0.6 and the evaporation as 3 feet, the difference in discharges, d is 4.17 feet in height of the lake. One foot in height of water on Lake Erie is equal to 8,934 cubic feet of water per second for one year; 4.17 feet on the lake, then, corresponds to an average discharge of 37,255 cubic feet per second

for the year.

The mean corrected level of Lake Erie, June 1 to December 1, is 572.57 and December 1 to June 1, 572.41. The quantity of water coming into Lake Erie from the Lake Erie drainage area being taken as 37,255 cubic feet per second, and the increase in discharge of Niagara River for a rise of 1 foot being 23,205 cubic feet per second, if the supply from Lake Erie drainage area was unform throughout the year would maintain the level of lake

 $\frac{37255}{23205} = 1.61 \text{ feet higher than it would be without this}$

supply.

The depth maintained, then, from June 1 to December 1 is 1.69 feet and December 1 to June 1, 1.53 feet.

Dividing d=4.17 into two parts that are to each other as 1.69 to 1.53 gives d'=2.19, d''=1.98. Substituting these values of d' and d'' in (39) and (40), and adopting for x' and x'' the values six-tenths, give E' the evaporation June 1 to December 1, 31 inches, and December 1 to June

1, 5 inches. The great inequality in the values of evaporation derived for the two halves of year indicate the winter run-off is probably more than six-tenths of rainfall and the summer run-off somewhat less.

WINDMILL POINT, FORT WAYNE, AND AMHERSTBURG GAUGES, DETROIT RIVER.

It is possible, when the heights of water surface at Windmill Point and at Fort Wayne on the Detroit River are known, to form a somewhat accurate estimate of what the height of water at the same time is at Amherstburg. The slope of the river is determined by any two gauges on the river, assuming that at a given instant the same quantity of water is passing through every crosssection of the river. There are only slight deviations from this condition in the case of the Detroit River, owing to small waves of short period traversing the river. Independent of seasonal variations, Lake Erie is subject to rapid changes of level due to strong winds. In the course of the 190 days in 1901 and 1902, for which there are observations of the gauge at Fort Wayne, the water at Amherstburg was as low as 569.62 December 10, 1901, and as high as 573.96 October 9, 1902. At Windmill Point during the same time the water was as low as 574.01, December 10, 1901, and as high as 575.82, July 29, 1902.

The least difference between Fort Wayne and Windmill Point gauge readings is 0.40 foot for the highest water at Amherstburg and the greatest difference 1.32 feet for the lowest. The range from high to low water at Amherstburg, corresponding to a variation in difference of 0.92 foot for Windmill Point minus Fort Wayne, is about

4.3 feet.

The sole cause of variation in difference of height of water at Windmill Point and Fort Wayne is the stage of water at Amherstburg. Any change in the stage at Amherstburg is followed by a corresponding change at Fort Wayne. It is not possible to determine very closely from the observations of water level what the wave time is from Amherstburg to Fort Wayne. In 15 cases examined, where the maximum stages apparently corresponded, the time varied from 15 minutes to 1 hour and 20 minutes.

Winds or secondary waves probably produce minor irregularities that mask the true time of maximum. The theoretical wave time between Amherstburg and Fort Wayne, 15.07 miles apart, is 46 minutes, taking the velocity of wave the same as that acquired by a body falling through a height equal to half the depth of the water traversed. The average depth of water from Amherstburg to Fort Wayne is 26 feet.

The stage at Windmill Point rises slowly for a rise at Amherstburg on account of the storage capacity of Lake St. Clair, which has an area of 503 square miles.

The stage at Amherstburg can not be told with any degree of accuracy from the stage at Fort Wayne only. The Fort Wayne stage varies directly as the Windmill Point stage, while the Windmill Point stage has no im-

mediately effect on the Amherstburg stage.

The relation of the Windmill Point, Fort Wayne, and Amherstburg stages has been derived by taking the observation of stages and arranging the differences, Windmill Point minus Fort Wayne corresponding to the differences, Windmill Point minus Amherstburg; according to the magnitude of the difference, Windmill Point minus Amherstburg. For this purpose the observations at the full hours were taken on all days when there were observations at Fort Wayne. The means of groups were taken for the differences, Windmill Point minus Amherstburg, 1.8 to 1.9 feet, 1.9 to 2.0, 2.0 to 2.1, etc., up to 3.8 to 3.9. The number of observations in a group varied from 12 for the small difference to 160 for the group 3.0 to 3.1. There were only four observations in the group greater than 3.9 feet.

Table XXII—Relation of Windmill Point, Fort Wayne and Amherstburg Gauges, Detroit River (1903 Levels).

	nill Point		ill Point us—		ill Point
Fort Wayne.	Amherst- burg.	Fort Wayne.	Amherst- burg.	Fort Wayne.	Amherst- burg.
Feet. 0.45 46 47 48 49 50 51 52 53 54 55 56 60 61 62 63 64 65 66 67 68 69 70	Feet. 1.26 1.33 1.40 1.48 1.55 1.62 1.66 1.70 1.74 1.79 1.83 1.86 1.89 1.92 1.92 2.05 2.05 2.01 2.14 2.18 2.22 2.25 2.29 2.33	Feet. 0.71 .72 .73 .74 .75 .76 .77 .78 .79 .80 .81 .82 .83 .84 .85 .86 .87 .88 .89 .90 .91 .92 .93 .94 .95 .96	Feet. 2.36 2.40 2.44 2.48 2.52 2.55 2.59 2.63 2.67 2.71 2.75 2.79 2.83 2.87 2.91 2.96 3.01 3.05 3.10 3.15 3.19 3.27 3.31 3.35 3.39	Feet. 0.97 .98 .99 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.08 1.09 1.10 1.11 1.12 1.13 1.14 1.15 1.16 1.17 1.18 1.19 1.20	Feet. 3.42 3.46 3.50 3.53 3.56 3.62 3.65 3.68 3.70 3.72 3.75 3.80 3.83 3.83 3.90 3.93 3.95 3.97 4.02 4.04

The means of these groups were plotted on cross-section paper, the differences Windmill Point minus Amherstburg being abscissas and Windmill Point minus Fort Wayne ordinates. A curve was drawn through these points. In Table XXII the relations of the gauges given

are taken from the curve.

The mean of the Windmill Point stages for the observations was 575.0 and the extremes about half a foot higher and half a foot lower. The difference between Windmill Point and Fort Wayne would vary slightly with the height at Windmill Point, even for the same difference between Windmill Point and Amherstburg. A half a foot rise or fall at Windmill Point causing a change of half a foot in the mean depth from Windmill

Point to Fort Wayne, which is 28 feet, would cause a variation of only 0.01 of a foot in the difference between Windmill Point and Fort Wayne for the average differ-

ence of level, which is 0.77 foot.

From Table XXII with the observed differences between Windmill Point and Fort Wayne the stages at Amherstburg were computed for the full hours 8 a. m. to 5 p. m. for the 1,579 cases on the 190 days for which there are observations at Fort Wayne, with the following results for the signs and magnitudes of the residuals Amherstburg stage, computed minus observed:

Number of residuals.

	Between-	Plus.	Minus.	Total.
0.00				32
0.00 and 0.10		370	282	652
.10 and .20		261	167	428
.20 and .30		127	145	272
.30 and .40		47	61	108
40 and .50		20	30	50
.50 and .60		2	14	16
.60 and .70		5	4	9
.70 and .80		0	8	8
.80 and greater		2	2	4

In about nine-tenths of the cases, then, the error in computed stage at Amherstburg is less than ± 0.30 foot. The cases where the errors are large are more numerous for high stages at Amherstburg than for low stages.

It may be said, then, that a fairly accurate estimate can be made of the height of water surface at Amherstburg, and consequently of the depth in the channel there, when the heights of water at Windmill Point and Fort Wayne are known. This would be useful information in the case of large boats coming down heavily loaded and drawing nearly all the depth of water available, when the water at Limekiln Crossing and Amherstburg is low. An indicator gauge at Windmill Point which the steamers pass quite near and one at Fort Wayne would give the heights from which, with Table XXII, the height at Amherstburg can be derived.

The distance from Windmill Point to Fort Wayne is 9.5 miles. The level of water in Lake St. Clair is not

subject to much change. In the hour required for the vessel to make the distance the change in Windmill Point level would rarely be as much as 0.01 foot. There have been, however, rare occasions when the change has been as much as 0.20 foot in an hour, changing back to the original stage very quickly. This has probably been due to boats passing near the gauge. At Amherstburg the greatest change in level of the water is not often more

than 0.10 foot per hour.

To lower the water in Lake St. Clair to a new normal corresponding to a low water at Amherstburg takes time. As has been shown, half the fall would be accomplished in two days and nine-tenths of the fall in six days. After the level of Lake St. Clair has reached the new normal the former normal slopes of the Detroit River are resumed very nearly. In such cases, then, the difference of level between Windmill Point and Fort Wayne would not give an indication of a low stage at Amherstburg. Long-continued low water at Amherstburg, however, rarely occurs. The very low stages that interfere with

navigation last only part of a day.

The readings of a gauge at Limekiln Crossing were made from November 30 to December 12, 1903, at tenminute intervals from 7:30 a.m. to 4:30 p.m. A comparison of these with the record of the automatic gauges at Amherstburg and Windmill Point gives, the relations shown in Table XXIII. From Limekiln Crossing to Amherstburg gauge is 2.07 miles. The Windmill Point and Fort Wayne water heights give the height of water surface at Limekiln Crossing as well as at Amherstburg. From Tables VIII and XXIII Table XXIV is obtained, which gives the difference in level of water between Windmill Point and Limekiln Crossing, corresponding to difference in height between Windmill Point and Fort Wayne.

TABLE XXIII.—Relation of Windmill Point, Limekiln Crossing, and Amherstburg Gauge. (1903 Levels.)

Windmill Point minus Amherst- burg.	Limekiln Crossing minus Amherst- burg.	Windmill Point minus Amherst- burg.	Limekiln Crossing minus Amherst- burg.	Windmill Point minus Amherst- burg.	Limekiln Crossing minus Amherst- burg.
Feet	Feet	Feet	Feet	Feet	Feet
1.5 1.6 1.7 1.8 1.9 2.0 2.1 2.2 2.3	0.15 .17 .19 .21 .23 .25 .27 .29	2.4 2.5 2.6 2.7 2.8 2.9 3.0 3.1 3.2	0.33 .35 .38 .41 .44 .47 .51 .55	3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0	0.63 .69 .75 .81 .87 .94 1.01 1.10

TABLE XXIV.—Relation of Windmill Point, Fort Wayne, and Limekiln Crossing Gauges, Detroit River.

	mill Point Minus		ill Point	Windmi Mi	
Fort Wayne	Limekiln Crossing	Fort Wayne	Limekiln Crossing	Fort Wayne	Limekila Crossing
Feet 0.45 .46 .47 .48 .49 .50 .51 .52 .53 .54 .55 .56 .57 .58 .59 .60 .61 .62 .63 .64 .65 .66 .67 .68 .69 .70	Feet 1.16 1.21 1.27 1.33 1.39 1.45 1.48 1.51 1.54 1.58 1.62 1.64 1.66 1.69 1.71 1.74 1.77 1.79 1.81 1.84 1.86 1.99 1.93 1.95 1.98 2.01	Feet 0.71 .72 .73 .74 .75 .76 .77 .78 .79 .80 .81 .82 .83 .84 .85 .86 .87 .88 .89 .90 .91 .92 .93 .94 .95	Feet 2.04 2.07 2.10 2.13 2.17 2.19 2.24 2.27 2.30 2.33 2.35 2.38 2.41 2.44 2.47 2.50 2.52 2.55 2.66 2.67 2.69 2.71	Feet 0.97 .98 .99 1.00 1.01 1.02 1.03 1.04 1.05 1.06 1.07 1.10 1.11 1.12 1.13 1.14 1.15 1.16 1.17 1.18 1.19 1.20	Feet 2.72 2.74 2.75 2.76 2.77 2.79 2.80 2.81 2.82 2.85 2.86 2.87 2.88 2.89 2.90 2.90 2.90 2.90

SUMMARY.

1. The formula for discharge of the St. Clair River in terms of heights of water surfaces of Lakes Huron and St. Clair, derived from observations of discharge made from 1899 to 1902, in cubic feet per second, is:

D (St. Clair)=195574+35145H-20928h

H= Fort Gratiot lighthouse minus 580.52 or Sand Beach minus 580.70

h-St. Clair Flats Canal minus 575.12.

2. The formula for discharge of the Detroit River, in terms of heights of water surfaces of Lakes St. Clair and Erie, derived from observations of discharge made in 1901 and 1902, in cubic feet per second, is:

D (Detroit)=200274+37483H'-21784h'

H'=Windmill Point lighthouse gauge minus 574.78 or St. Clair Flats Canal gauge minus 575.12.

h'=Amherstburg gauge minus 572.22 or Cleveland gauge minus 571.96.

3. The height of water surface of Lake St. Clair in relation to heights of Lakes Huron and Erie is given by the equation

h=0.602H+0.373h'

h—St. Clair Flats Canal gauge minus 575.12 H—Sand Beach gauge minus 580.70.

h'=Cleveland gauge minus 571.96.

4. The formula for the discharge of St. Clair and Detroit rivers considered as one, in terms of heights of Lake Huron and Lake Erie, is:

D(St. Clair-Detroit)=200274+22553H-7805h'

This formula is derived from the formulae for St. Clair and Detroit rivers by eliminating the St. Clair gauge. The formula is only applicable for mean values covering a considerable period, at least one month.

5. The value of c in the Chézy formula is 60.6 derived from the stretch of St. Clair River from Fort Gratiot lighthouse to G. T. R. gauge. The distance is 0.80 mile, the slope 0.0001989, the width 1,015 feet, the depth 37 feet, and the velocity of water 5.19 feet per second. The value of c for the stretch of river from c G. T. R. gauge to St. Clair Flats Canal is 111. The distance is 39 miles, the slope 0.0000239, the width 2,430 feet, the depth 28 feet, and the velocity of water 2.87 feet per second.

The discharge formulae apply for small values of H, h, H', and h' near the datum stages. For stages very different from the datum, terms in the squares and products of H and h derived theoretically are appreciable and should be applied to obtain the best value of the dis-

charge.

7. The difference of 4,700 cubic feet per second adopted in the datum discharges of the St. Clair and Detroit rivers is derived by taking it to be a part of the discharge of the Niagara River proportional to the Lake St. Clair drainage area as compared with the whole drainage area

of the lakes above Niagara River.

8. The observed discharge of Detroit River for the stages Windmill Point 574.99 and Amherstburg 572.35, which are the means during the time of observation of discharges, is 198,959 cubic feet per second. Reduced to the datum stage Windmill Point 574.87, Amherstburg 572.22, the discharge is 197,293 cubic feet per second.

9. With the discharge of the Detroit River 4,700 cubic feet per second greater than that of the St. Clair River on the average for the year, and giving St. Clair double the weight of Detroit on account of the greater number of observations, the datum discharge of the St. Clair River is 195,574 and of the Detroit River 200,274 cubic feet per sec-

ond. These are the adopted datum discharges.

10. The average discharge of Detroit River for eleven years, 1893 to 1903, is 193,854 cubic feet per second. The average discharge of Niagara River for the same time is 197,328 cubic feet per second. The discharge of Niagara River should be greater than the discharge of Detroit River by the quantity of water coming from the drainage area of Lake Erie. This quantity, if taken as a part of the outflow through Niagara River proportional to the area of the Lake Erie drainage area as compared with the whole drainage area of the lakes above the Niagara River,

should be 30,100 cubic feet per second. Either the Detroit River discharge, therefore, is too large or the Niagara

River discharge too small.

11. If there is no greater difference in the discharges of the Detroit and Niagara rivers than the observations show, it would indicate an evaporation from the surface of Lake Erie of 81.4 inches for the year, a quantity greater than seems admissible. This assumes a run-off of sixtenths of the rainfall on the land part of the drainage area of Lake Erie.

12. The adopted datum discharges for the St. Clair and Detroit rivers are possibly too large and the discharge of the Niagara River too small by very considerable quantities, 10,000 cubic feet per second, or even more.

The differences in the discharges of the St. Clair and Detroit rivers, derived from the monthly mean gauge readings for past years at Sand Beach, St. Clair Flats Canal, and Cleveland, show great differences in the winter months, which are due to ice gorges in the St. Clair and Detroit rivers. These ice gorges are more frequent in the St. Clair than in the Detroit River. When the computed St. Clair discharge is very much greater than that of the Detroit, it indicates the blocking of water is in the St. Clair River. When the Detroit discharge is larger than the St. Clair, it shows the blocking is in the Detroit River. As the discharge of one river must be equal to that of the other, the less value of the discharge is probably more nearly the true one. There is no certainty, however, but what both rivers may be blocked and both computed values incorrect. Even without an ice blockade, an ice covering in winter diminishes the discharge for January, February, and March about 10,000 cubic feet per second by diminishing the cross-section of river. The friction of water on underside of ice probably reduces the discharge 6,000 cubic feet per second farther.

14. The differences in the monthly mean discharges in the summer season show that previous to 1893 the computed St. Clair River discharges are greater by about 11,000 cubic feet per second than those of the Detroit River. This may be due to errors in the formulae for discharge, or changes in either the St. Clair or the Detroit rivers. A change is more likely in the St. Clair than in

the Detroit River, because of the swifter current, softer

bottom, and more frequent ice gorges.

15. The error, if in the formulae, may be either in the co-efficients or in the datum discharge. Any reasonable supposition in regard to error in the co-efficients would not account for more than one-fourth of the amount of the differences. Very considerable changes in the Detroit River co-efficients would not alter the differences much, as there is very little variation in the mean monthly slope of the Detroit River.

16. For given datum stages of the St. Clair River there is a certain discharge of the river. If a layer 1 foot in thickness was removed from the bottom of the river without disturbing the surface elevation of the water, the discharge for datum stage would be increased, by reason of the increased cross-section and the increased

velocity due to the greater depth.

17. The computed discharges of the St. Clair River being larger than those for the Detroit River can be explained by supposing the bottom of the river lower since 1893 than it was previous to that time. The differences of computed discharges for 1873 to 1892, as compared with 1893 to 1903, indicate a lowering of about 0.8 foot.

18. A rise of 1 foot in Lake Huron produces a proximate rise of 0.602 foot in Lake St. Clair before producing much rise in Lake Erie. A rise of 1 foot in Lake Erie produces a proximate rise of 0.373 foot in Lake St. Clair before the backwater effect in Lake Huron takes place.

19. Five-tenths of the proximate rise in Lake St. Clair, due to a rise in Lake Huron, occurs 46 hours after the Lake Huron rise, and nine-tenths of the rise 154 hours

after.

20. A rise of 1 foot in Lake Huron, if continued, would eventually produce a rise of 0.727 foot in Lake Erie.

21. Five-tenths of the rise in Lake Erie, due to a rise in Lake Huron, will be accomplished 72 days after, and

nine-tenths of the rise 239 days after.

22. Taking 10,000 cubic feet of water per second from Lake Michigan through the Chicago drainage canal will eventually lower the level of Lake Huron 0.521 foot, the level of Lake St. Clair 0.455 foot, and the level of Lake Erie 0.379 foot. Half the fall in Lake Huron will take place in 1.46 years, and nine-tenths of the fall in 4.86 years.

23. The times required for changes in Lake St. Clair,

corresponding to changes in Lakes Huron and Erie, are independent of the magitudes of the changes and are the same whether one lake is falling and the other rising, or the reverse.

24. The backwater rise in Lake St. Clair for a rise of 1 foot in Lake Erie will be 0.581 foot when the backwater rise in Lake Huron will have been completed. The backwater rise in Lake Huron for a rise of 1 foot in Lake St. Clair is 0.595 foot. The backwater rise in Lake Huron for a rise of 1 foot in Lake Erie is therefore 0.346 foot.

25. Comparing rainfall over the lake region for sixteen years, 1883-1898, with the annual change of lake levels and discharges through the connecting rivers, it is possible to form some idea of the evaporation from lake surface and the run-off from the land part of drainage area.

age area.

For Lake Superior the evaporation from the surface of lake is less than 18 inches for the year, with a run-off from the land surface of six-tenths of the rainfall. Very little of the winter precipitation on land reaches the lake.

26. For Lakes Michigan-Huron, taking the run-off from the land as six-tenths, the evaporation from the lake

surface is 33 inches for the year.

27. For Lake Erie, adopting the run-off from the land part of the drainage area for the year as six-tenths of the rainfall and the evaporation from lake as 3 feet, gives the excess of discharge of Niagara River over that of Detroit River as 37,255 cubic feet per second.

28. With indicator gauges at Windmill Point and Fort Wayne docks, the readings made from the deck of a passing steamer would enable one by means of Table XXII to tell the height of water surface at Amherstburg within

half a foot throughout a range of about 4 feet.

Credit is due to Mr. Sherman Moore for much valuable assistance in the preparation of this report and in making a great part of the computations.

Very respectfully,

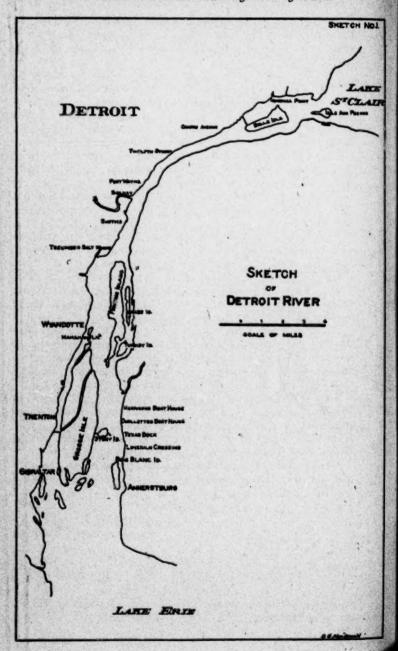
THOMAS RUSSELL, Assistant Engineer.

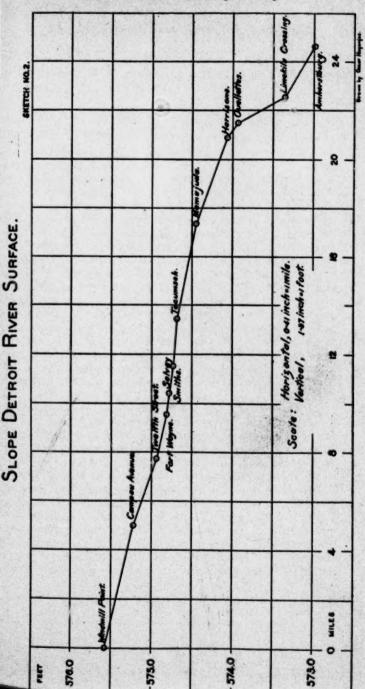
Maj. W. L. Fisk,

Corps of Engineers, U. S. Army."

Chief of Engineers Report, 1904, App. EEE. pages 4120-4131.

Opposite hereto are inserted Sketches No. 1 and No. 2 which appear in said report.





EXTRACT FROM REPORT OF MAJOR KELLER, U. S. ENGINEER, DETROIT, JULY 19, 1909.

Chief of Engineers Report, App. FFF, p. 2490.

"During the year 1908 the level of Lake Ontario was higher than it has recently been, the highest monthly mean, 248.62, that of June, being the highest stage for that month since 1870. The July stage, 248.34, was slightly exceeded in 1876, but in no other July since 1862. Accordingly a valuable opportunity offered for extending the range of the discharge observations of the St. Lawrence River, those of 1900 and 1901, which covered only the range from 243.7 to 246.2 feet on the Oswego gauge.

The hydraulic party of the Lake Survey was, at the beginning of the fiscal year, engaged on work on the Niagara River in connection with allotments from the appropriation made in the act of June 29, 1906. This work was not completed until late in August, so that necessarily the high stages of July and August for Lake Ontario were lost. On August 28, 1908, this party, under Junior Engineer Sherman Moore, on the steamer No. 1, left Buffalo via the Welland Canal, for the St. Lawrence River.

On September 8 the party arrived at Waddington, N. Y., near Section Three Points, which had been used in the discharge measurements of 1900 and 1901. This section was relocated and all preliminary work completed by September 21, and between that date and October 2, 26 separate discharges were measured at stages between 246.6 and 247.3 on the Oswego gauge. Including the work of 1908, 122 separate discharge measurements, covering a range of 3.6 feet on the Oswego gauge—i. e., from 243.7 to 247.3—have now been made. The following tables contain the details of the recent discharge measurements and also certain characteristic and limiting discharges computed from the results of all available measurements.

U. S. LAKE SURVEY, HYDRAULICS OF ST. LAWRENCE RIVER. Summary of discharge measurements.

			Elevation of water surface.						e in leve lensburg
No.	Date.	Ogdens- burg.	Section.	Lock 27.	Look 34.	Lock 21.	Ogdens- burg to section.	Rise.	Pall.
101 102 103 104 105 108 109 109 110 111 112 113 114 115 117 118 119 120 121 121 122 123 124 125 126	1908. Sept. 21 Sept. 23 Sept. 23 Sept. 24 Sept. 34 Sept. 36 Sept. 36 Sept. 36 Sept. 36 Sept. 36 Sept. 30 Sept.	245, 90 345, 80 345, 90 345, 90 345, 90 345, 90 345, 90 345, 70 345, 70 345, 70 345, 70 345, 70 345, 70 345, 70 345, 70 345, 70 345, 84 346, 70 346, 70 346, 17 346, 17		17. 02 14. 59 14. 59 15. 59 16. 59 16. 59 16. 59 16. 59 16. 59 16. 59 16. 72 16. 72 16	18.08 17.76 17.65 17.85 17.78 17.79 17.79 17.73 17.73 17.76 17.73 17.76 17.77 17.78 18.25 18.25 18.25 18.25 17.66	16. 81 16. 65 16. 61 16. 63 16. 63 16. 63 16. 63 16. 63 16. 67 16. 67 16. 57 16. 57 17. 03 16. 59 16. 50 16. 50 16. 50 16. 50 16	17. 61 17. 60 17. 66 17. 66 17. 70 17. 70 17. 70 17. 77 17. 77 17. 71 17. 66 17. 70 17. 70 17	.00	0. 18 .000 .000 .000 .000 .000 .000 .000 .0
No.	Date.	Wi Direc- tion.		1 B meter.		of dischar	1	pted.	Weight ed mean index velocity
101 102 103 104 105 106 107 108 100 110 111 111 115 116 117 118 119 122 123 124 124 125	1908. Bept. 21 Sept. 23 de Sept. 23 de Sept. 25 de Sept. 26 de Sept. 26 de Sept. 26 de Sept. 26 de Sept. 27 de Ge	0 0 8W. 8W. 0 0 W. 2 8 8. 8 W. 8 8 W	0 0 6 4 6 4 0 2 2 0 0 0 0 12 18 20 16 20 20 20 20 20 20 20 20 20 20 20 20 20	267, 530 284, 030 264, 730 264, 730 368, 180 263, 500 263, 500 263, 500 263, 500 263, 260 277, 730 280, 620 287, 530 287, 530 287	257, 78 259, 67 251, 00 254, 26 254, 30 254, 30 254, 30 255, 30 255, 37 260, 22 260, 22 260, 22	296, 10 206, 1	780 2800 2800 2800 2800 2800 2800 2800 2	08, 000 50, 500 59, 400 64, 700 68, 200 60, 800 60, 800 60, 400 82, 300 82, 300 82, 300 82, 300 82, 300 82, 300 82, 300 82, 300 83, 600 83, 600 81, 200 81, 200 81, 200 81, 200 81, 200 81, 300 81, 300 81, 300 81, 300 81, 300 81, 300 81, 300 81, 300 81, 300	5.25 5.26 5.26 5.29 5.29 5.29 5.29 5.29 5.29 5.29 5.29

J. S. LAKE SURVEY, HYDRAULICS OF ST. LAWRENCE RIVER—continued.

Equivalent	gauge heights	and corresponding	dischurges.
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Elevation of water surface at-					River				
Oswego.	Ogdens- burg.	Lock 27.	Lock 24.	Lock 21.	dis- charge.	Equations.			
243.00 243.50	242.22 242.60	13.21 13.68	12.77 13.46	13. 16 13. 63	162, 100 174, 100	Discharge =5417 (6.809+0.943 Oswego=240) Ogdensburg=229.392+0.943 (Oswego=240).			
244.00 244.50	243. 16 243. 64	14.15	14.14	14.10	186,300 199,200	Discharge =5417 (7.417+ Ogdensburg-240) Lock 27 =10.99+ (Ogdensburg-240).			
245.00	344.11	18.10	15. 47	15.00	212,000	Discharge =5417 (Lock 27-3.573)			
245.50 246.00	244.58 245.06	15.57	16.11	15. 47	225, 100 238, 500	Lock 24 -7.962 (Lock 27-3.573)**-14.16 Discharge -16.14 (Lock 24+14.10)**-			
245.50	245.52	16.51	17.36	16.34	252, 100	Lock 21 -3.432 (Lock 27-3.573)			
247.00 247.50 - 248.00	245. 90 246. 46 246. 94	16.98 17.45 17.93	17. 96 18. 56 19. 16	16.77 17.20 17.63	365, 900 380, 000 384, 700	Leck 21 -0.3738 (Lock 24+14.10) ²⁸ -1.86 Discharge -317.6 (Lock 21+1.86) ²⁴ .			

Immediately upon the conclusion of this work the discharge section was permanently marked by concrete monuments, adequately referenced to adjacent prominent objects, and on October 5 the steamer carrying the party and its equipment left for Detroit and Port Huron, arriving at the latter place on October 30, after delays en route for various purposes, including necessary repairs to the steamer and rating of meters at Buffalo. Arrived at Port Huron, the party at once proceeded to establish the necessary gauges and to reproduce and sound Section Dry Dock, on which most of the discharge measurements of the St. Clair River have in the past been made. In all, on November 7, 9, 10, 11, 21, 23, and December 14 and 18, fifteen discharge measurements were made at this section, and for the purpose of verifying the results obtained these were compared with twenty-two discharges measured between November 18 and December 19 at a carefully chosen and accurately sounded new cross section, called "Section Gorge," located in the narrow reach of the river just below its head. While these discharge measurements do not extend the range of the former work on the St. Clair River, they are valuable in that the work at Section Gorge gives results varying less than 2 per cent. from those derived from Section Dry Dock. The equations derived from the hydraulic work at the latter section remain, therefore, uncontradicted and, within the limits of observation, deserve confidence.

In 1898 and 1899 a number of sections of the St. Clair River were established by Assistant Engineer Sabin, closely sounded, and referenced to surrounding objects. The object of these sections was to determine the presence or absence of scour and consequent change of river regimen in the upper river. Four of these sections (Culvert, Fish, Arthur and Stauber), well toward the head of the river, which had been resounded in 1901 and 1904, were again sounded December 5 to 8, 1908.

The following table furnishes a comparison between the areas of cross section as originally determined and those de-

rived from the soundings of 1908.

U. S. LAKE SURVEY-HYDRAULICS OF ST. CLAIR RIVER.

Comparison of soundings on sections at the head of St. Clair River.

Data for 1886 from report of Assistant Engineer L. C. Sabin for 1900; lead-line work.

Data for 1901 and 1904 from report of W. J. Graves, junior engineer, May 11, 1905; 45-pound weight on
No. 14 bronne wire.

Data for 1906 from soundings of December, 1908, by Sherman Moore, junior engineer; 135-pound weight on steel plane wire.

Section	Distance from Fort Gratiot light- house.	Year.	Wighth of section.	Depth.		1 6	ATT THE PART OF
				Maxi- mun.	Mann.	Ares.	Bemarker
Culvert	Feet. 1,200	1800	Pad 1, 600 1, 410	Pad.	744	Sy. /ac. 64,900 44,900	A scour of about 1.3 fact is indicated on this section since 1901.
716	2,180	1906 1900 1901 1904	1,600 1,600 1,010 1,010	71.8 65.0 63.6 64.2	31.0 31.0 31.7	46,800 34,800 34,800 36,100	Apparent shosting indicated by mean depth is due to increase in width. No change is shown in area.
Arthur	8,900	1906 1900 1901 1904	1,060 800 800	65.0 63.3 63.9	4.7 40.5 40.0	34, 800 35,000 22, 400 22, 800	A filling in of about 2.5 feet is indi- ested on this section. May be due in part to wreak of Martin, which
Stauber.	8,800	1809 1901 1906 1800 1901 1904 1809 1901 1904 1805 1809 1901 1904	1,010 1,000 800 800 800 800 940 940 940	60.6 60.5 64.5 44.0	86.2 86.2 84.6 86.6	14,000 14,000 12,400 14,000	No change shown here. Soundings of 1901 probably sightly in error.

It will be seen that virtually no change has taken place at the head of the river, and that for the period covered by the observations its regimen appears to be stable.

Chief of Engineers Report, 1909, App. FFF, pages 2490-2493.

EXTRACT FROM REPORT OF LIEUT. COL. C. S. RICHE, DETROIT, MICH., JULY 27, 1912.

Chief of Engineers Report 1912, App. FFF, p. 3544.

"Water Levels.

The stage of water in the lakes and in the interlake and outflow rivers has been recorded as heretofore by the regular series of self-registering gauges. A smalltype automatic gauge was also maintained during the summer season of 1911 on the pile cluster at the head of St. Clair River, for the purpose of further strengthening the determination of relationship between this—the Fort Gratiot gauge—and other standard gauges. The records of this gauge have been used in connection with the determination of slopes and the reductions of discharge measurements for the St. Clair River. The automatic gauge at Buffalo was moved in October, 1911, from the end of the breakwater to a new gauge house at the inner end of the slip belonging to the Bureau of Lighthouses. The change was made necessary by the rebuilding of the fog-signal station in which the gauge was formerly located. All of the standard gauges are now in excellent condition.

Including the St. Clair Flats gauge, which is maintained by the United States engineer office under charge of Col. C. McD. Townsend, Corps of Engineers, during the season of navigation, and by this office during the winter, the Lake Survey now maintains 10 self-registering gauges and 1 staff gauge, as follows:

1. Lake Ontario, at Tibbetts Point.

Lake Erie, at Buffalo.
 Lake Erie, at Cleveland.

4. Detroit River, at Fort Wayne.

5. Lake St. Clair, at Windmill Point (Staff).

6. St. Clair River, at head of St. Clair Flats Canal.

St. Clair River, at Port Huron.
 Lake Huron, at Harbor Beach.

9. Straits of Mackinac, at Mackinaw City.

Lake Michigan, at Milwaukee.
 Lake Superior, at Marquette.

In addition, this office received records of the selfregistering gauges maintained by the district offices, as follows: Detroit River at Amherstburg, Lake Michigan at Chicago, St. Marys River below the locks, and St. Marys River above the locks, and records of staff gauge readings on Lake Ontario at Oswego and on Lake Superior at Houghton and Duluth.

The zeros of all gauges maintained by the Survey have been carefully checked during the past year and the instruments overhauled. The records are for the most

part excellent.

Monthly means of water level for stations named, expressed in feet above mean tide at New York. (Adjusted levels of 1903.)

1911	July.	August.	Septem- ber.	October.	Novem- ber.	Decem- ber.
Marquette	601.62	602.09	602.18	602.18	602.03	601.90
Milwaukee	579.85	579.80	579.71	579.61	579.33	579.44
Harbor Beach	579.93	579.85	579.58	579.56	579.44	579.39
Cleveland	571.75	571.61	571.52	571.53	571.13	571.42
Oswego	245.54	245.19	244.88	244.62	244.50	244.63

Monthly means of water level for stations named, expressed in feet above mean tide at New York—Continued.

1912	January.	Febru- ary.	March.	April.	May.	June.
Marquette	601.76	601.53	601.48	601.45	601.91	602.21
Milwaukee	579.27	579.29	579.35	579.52	580.05	580.46
Harbor Beach	579.35	579.23	579.22	579.44	579.89	580.45
Cleveland	571.28	571.08	571.23	572.28	572.59	572.66
Oswego	244.76	244.87	245.10	246.32	246.82	247.34

There is herewith a sheet showing the monthly mean water levels of all the Great Lakes from January, 1860, to June, 1912, inclusive.

During the year there has been issued a series of notices to navigation interests giving the monthly mean stages for all the lakes during the preceding month, comparing these stages with corresponding ones for critical years, and predicting the stages to be expected for the following month. These notices have been accepted as authoritative and of great usefulness.

INVESTIGATION OF LAKE LEVELS.

The taking of air and water temperatures was continued during the field seasons by the steamer parties engaged on hydrographic and magnetic work. The study of river flow and the related subject of lake levels have received particular attention during the year. Slope relations on the rivers have been revised from all available data, and profiles of St. Marys, St. Clair, Niagara, and St. Lawrence Rivers have been constructed to show surface slopes at mean stages and at lowwater planes.

The hydraulic measurements on the St. Clair River obtained in 1910 have been combined with the measurements of 1899-1902 and 1908-9 in deriving a new discharge formula for this river. After considerable study and a test of several formulas with groups of observed gauge heights and discharges, a modification of the submerged-weir formula was accepted as

best fitting the conditions. The formula adopted is:

 $Q = K[(Fort Gratiot-y) + a(St. Clair Flats-y)]F^{\frac{1}{2}}$

in which F is the fall from Fort Gratiot to St. Clair Flats and K, a, and y are constants to be derived by solution. In applying this equation as first solved to the observed quantities it was found that residuals were grouped by size or sign for the various years. Assuming that this variation of discharge for the different years of observation is due to change of regimen, a second solution was made, in which the constants K and a were determined from all the observations, and y, which represents the elevation of the mean river bed, was determined for each separate year. This solution gives the equation:

 $Q=3758[(Fort Gratiot-y)+1.25 (St. Clair Flats-y)]F^{1}$

in which the value of y for different years is as follows: 1899, 567.44; 1900, 567.58; 1901, 567.33; 1902, 567.64; 1908, 567.61;

1909, 567.51; and 1910, 567.51.

These values give equations which satisfy closely the relationship between observed discharges and gauge heights for each year. The mean residual for the 488 measurements of flow is 1.41 per cent. From the 1910 equation the increment at mean lake tivel for Lake Huron (Harbor Beach) is 28,310 cubic feet per second. The backwater increment for Lake St. Clair (St. Clair Flats) is 8,280 cubic feet per second.

The variation in stage on Lake St. Clair during the years of

record averages 66 per cent. of the change at Harbor Beach, and the stage at St. Clair Flats is represented by the equation:

St. Clair Flats=574.85+0.66 (Harbor Beach-580).

From this relationship the flow of the St. Clair River for mean lake level, 1860-1911, inclusive, by the 1910 equation is 207,750 cubic feet per second and the normal increment for 1 foot on Lake Huron is 22,850 second-feet.

The above equation may be applied to Lake Huron stages at Harbor Beach by first reducing these stages to terms of

Fort Gratiot gauge heights by the equation:

Fort Gratiot=579.85+0.987 (Harbor Beach-580).

Table No. 1 gives the discharge of St. Clair River by the 1910 equation in terms of stages at Harbor Beach and St. Clair Flats.

TABLE No. 1.—Discharge, in hundreds of cubic feet per second, for soster-surface elecations at Harbor Beach and St. Clair Flats.

Eleva-	1.0				EF	ration	at St. C	lair Fla	ds.				
Iarber Beach.	574.0	574.1	874.3	574.3	874.4	574.5	574.6	574.7	574.8	574.9	875.0	875.1	575.
578.5	1400	1683	1674	1485	1480 1484 1500	1440	1400	1439	1418	1407	1306	1388	137
578.6 578.7 578.8 578.9 579.0 579.1 579.2	1530	1507 1507 1509 150 1600	1894	1517	1500	1800	1401	1451	1471	1400	1440	1437	100
578.8	1539 1563 1568 1613	1584	1340	1543	1834 1880 1884	1836	1517	1807 1833 1860 1866 1813	1697	1487	3476	1465	16 16 15
878.9	1588	1851	1574	1367 1393 1618	1884	1583 1577 1800 1608 1663	1543 1548 1594 1690 1645 1671	1560	1550	1513 1540 1546 1566	1508	1519	1
579.1	1637	1831	1000	1618	1810	1000	1004	1886	1550 1576 1602 1626	1506	1556	1546 1573	18
579.2	1663	1631	1640 1674 1690	1643 1668 1663	1606	1028	1600	1612	1000	1808	1883	1573	15 15 16
579.3	1687	1631	1674	1008	1001	1679	1045	1003	1055	1646	1000	1000	10
579.4	1711	1705	1724	1718	1711	1706		1004		1673	1063	1607 1654	16
579.3 579.4 579.5 579.6 579.7	1761	1755	1749	1743	1726	1730	1722	1718	1,707	1073	1000	1061	16
579.7	1785	1755 1780	1774	1768	1788	1786	1748	1741	1793	1774	1716	1707	10
579.8	1810	1876	1790	1793	1788	1761	1773	1767	1789	1781	1743	1761	17
880.0	1850	1654	1840	1844	1813	1888	1995	1819	1811	1804 1830	1795	1787	19
\$80.1	1884	1279		1844	1864	1957	1850	1844	1837	1830	1823	1814	18 18 18 18 18
580.2	1900	1904	1800	1804 1900	1014	1862	1876	1570	1873	1886	1840	1841 1867	1
MO. 4	1958	1964	1900	1945	1940	1934	1902	1922	1918	1900	- 1875 2901	1204	19
580. 5	1958 1987	1979	1975	1970	1965	1980	1964	1870 1898 1922 1948	1041	1904	1906	1901	15
580.6	2005	2004	1994 1994 1990 1975 2000 2025	1995	1940 1965 1901 2016	1986	1960	1974 2000 2006 3000	1967	1965	1986 1984 1981 2008	1904 1901 1947 1974	1 4
580.7	3033	2055	2000	3048 3048	2010	2011	3006	2004	1994	2015	2000	2001	1
880.9	2033 2058 2063	2000	3080 3078 3100	2071	2067	3003	3006	3000	2020 2046	2018 2041 2041 2047	384	2001 2007 2064	2
881.0	2108	2090 2106	2100	2006	2083	1781 1806 1832 1867 1862 1964 1960 1966 2011 2006 2012 2017 2113	2063 2109	2078 3104 2130	2073	2007		3054	10 10 10 20 20 21
551.1	2133 2156	2130 2186	3135	2131	2117	3113	2135	3106	2125	2004	2113	3107	
531.3	2183	2180	2180	3,73	2100	2130 2164	2160	2186	2151	2146	9120	9134	21
801.4	2205	2205	2301	2198	2194	0100	3186	3183	2177	2173	2165	2160 2167	21
831.5	2233 2258	2230 2255	2236	2223	2220	2216	2213	2307	200	2190	9144 9199 9199	300	1 7
879.8 879.9 880.0 880.0 880.3 880.3 880.8 880.8 880.9 881.1 881.2 881.2 881.5 881.6 681.7 881.5	2208	2280	2201 2236 2251 2276	2274	2346	2346	2213 2317 2313	2220	200	225	200	2960	-
881.8			2301 2336	2200 2324	2207	2503 2018		2307 2333 2339 2339 2319	2000	1 2077	4010	2967	2
581.9 582.0	*****	******	2336	3324	2333	2318	2314	2310	2005	200	2000	2	

Table No. 1.—Discharge, in hundreds of cubic feet per second, for water-surface elevations at Harbor Beach and St. Clair Fluts—Continued.

Eleva-	188				Ele	rvation	at St. C	lair Fla	ts.		West Property		
Harbor Beach.	575.3	575. 4	575.5	575.6	575.7	575.8	575.9	576.0	576.1	876.2	576.3	578.4	576.
578. 5 578. 7 578. 7 578. 7 578. 7 578. 9 578. 9 578. 9 578. 9 578. 2 578. 3 579. 6 579. 6 57	1357 1365 1413 1441 1466 1453 1453 1453 1453 1453 1453 1453 1453	13-G 1371 1399 1427 1-452 1399 1421 1390 1390 1390 1390 1390 1390 1390 139	1329 1344 1414 1417 1419 1419 1419 1419 1419 14	3113 3142 3150 3150 3150 3150 3150 3150 3150 3150	1298 1297 1256 1414 1415 1416 1416 1416 1416 1416 14	1279 1300 1310 1310 1310 1310 1310 1407 1407 1516 1517 1516 1517 1516 1517 1517 151	1300 1291 1422 1553 1412 1553 1412 1551 1412 1551 1551 1551 1551 1551	1944 1975 1976 1976 1977 1977 1977 1977 1977 1977	1256 1287 1318 1349 1410 1379 1410 1411 1471 1471 1471 1471 1471 1471	1200 1331 1350 1351 1350 1351 1355 1355 1455 1455 1455 1455 1455	1390 1312 1314 137 1407 1408 1407 1408 1408 1511 1408 1710 1710 1710 1710 1710 1710 1710 17	12965 13367 1450 1450 1450 1450 1450 1450 1450 1450	133 140 140 140 140 140 140 140 140 140 140

The discharge measurements of the St. Lawrence River made in the spring and fall of 1911 have been combined with the measurements of 1908 in deriving a new discharge formula for this river in terms of Lake Ontario levels recorded at Oswego. Hydraulic data for the St. Marys and Niagara Rivers have been revised and combined.

Revised discharge equations and the years of measurement from which they were derived are as follows:

St. Marys River, 1909:

Discharge (rapids)=26.740+15,300 (S. W. Pier-600).3/2

For total river flow add 20,060 cubic feet per second. St. Clair River, 1910:

Discharge=3,758 [(Ft. Gratiot-567.51)+1.25 (St. Clair Flats-567.51)] (Ft. Gratiot-St. Clair Flats)*

Niagara River, 1899-1900, 1907-8.

Discharge=3,904 (Buffalo-558.37)3/2

St. Lawrence River, 1908, 1911.

Discharge=4,009 (Oswego-230.65)^{8/2} 62304°-ENG 1912-228

The following table gives a summary of discharges by these present accepted formulas corresponding to mean elevations of the various lakes for the last 52 years;

Table of mean discharges.

Mean elevation for 82 years (1800-1911) above mean tide York City, in feet.	at New	Corresponding mes in cubic feet of second. ¹	n discharge water per	
Lake.	Stage.	River.	Discharge.	
Superior— Michigan-Huron St. Clair at Plats Canal Erie Outario.	602.28 681.25 675.67 572.56 246.18	St. Marys St. Clair Detroit Niagars St. Lawrence	\$6,000 208,000 213,000 210,000 245,000	

Chief of Engineers Report, July 27, 1912, Appendix FFF, pages 3544-3548

TREATY BETWEEN THE UNITED KINGDOM AND THE UNITED STATES OF AMERICA BELATING TO BOUNDARY WATERS AND QUESTIONS ARISING ALONG THE BOUNDARY BETWEEN CANADA AND THE UNITED STATES, SIGNED AT WASHINGTON, JANUARY 11, 1909.

Treaty relating to Boundary Waters and Questions arising along the Boundary between Canada and the United States, signed at Washington, January 11, 1909*

His Majesty the King of the United Kingdom of Great Britain and Ireland and of the British Dominions beyond the Seas, Emperor of India, and the United States of America, being equally desirous to prevent disputes regarding the use

Harmon (1997)	
*Ratifications advised by the Senate	March 3, 1909
Balle 2 to 10 Paris	April 1 1910
Ratified by the President	april 1, 1010
Ratified by Great Britain	.March 31, 1910
Ratifications exchanged at Washington	May K. 1910
Mathications exchanged at washington	37 49 4040
Proclaimed	May 13, 1910

of boundary waters and to settle all questions which are now pending between the United States and the Dominion of Canada involving the rights, obligations or interests of either in relation to the other or to the inhabitants of the other, along their common frontier, and to make provision for the adjustment and settlement of all such questions as may hereafter arise, have resolved to conclude a Treaty in furtherance of these ends, and for that purpose have appointed as their respective Plenipotentiaries:

His Britannic Majesty, the Right Honourable James Bryce, O. M., his Ambassador Extraordinary and Plenipotentiary at

Washington; and

The President of the United States of America, Elihu Root,

Secretary of State of the United States;

Who, after having communicated to one another their full powers, found in good and due form, have agreed upon the following Articles:

Preliminary Article

For the purposes of this Treaty boundary waters are defined as the waters from main shore to main shore of the lakes and rivers and connecting waterways, or the portions thereof, along which the international boundary between the United States and the Dominion of Canada passes, including all bays, arms, and inlets thereof, but not including tributary waters which in their natural channels would flow into such lakes, rivers, and waterways, or waters flowing from such lakes, rivers, and waterways, or the waters of rivers flowing across the boundary.

ARTICLE 1

The High Contracting Parties agree that the navigation of all navigable boundary waters shall for ever continue free and open for the purposes of commerce to the inhabitants and to the ships, vessels, and boats of both countries equally, subject, however, to any laws and regulations of either country, within its own territory, not inconsistent with such privilege of free navigation, and applying equally and without discrimination to the inhabitants, ships, vessels, and boats of both countries.

It is further agreed that so long as this Treaty shall remain in force this same right of navigation shall extend to the waters of lake Michigan, and to all canals connecting boundary waters and now existing or which may hereafter be constructed on either side of line. Either of the High Contracting Parties may adopt rules and regulations governing the use of such canals within its own territory, and may charge tolls for the use thereof; but all such rules and regulations and all tolls charged shall apply alike to the subjects or citizens of the High Contracting Parties and the ships, vessels, and boats of both of the High Contracting Parties, and they shall be placed on terms of equality in the use thereof.

ARTICLE 2

Each of the High Contracting Parties reserves to itself, or to the several State Governments on the one side and the Dominion or Provincial Governments on the other, as the case may be, subject to any Treaty provisions now existing with respect thereto, the exclusive jurisdiction and control over the use and diversion, whether temporary or permanent, of all waters on its own side of the line which in their natural channels would flow across the boundary or into boundary waters; but it is agreed that any interference with or diversion from their natural channel of such waters on either side of the boundary, resulting in any injury on the other side of the boundary, shall give rise to the same rights and entitle the injured parties to the same legal remedies as if such injury took place in the country where such diversion or interference occurs; but this provision shall not apply to cases already existing or to cases expressly covered by special agreement between the parties hereto.

It is understood, however, that neither of the High Contracting Parties intends by the foregoing provision to surrender any right which it may have to object to any interference with or diversions of waters on the other side of the boundary the effect of which would be productive of material injury to the navigation interests on its own side of the boun-

dary.

ARTICLE 3

It is agreed that, in addition to the uses, obstructions, and diversions heretofore permitted or hereafter provided for by special agreement between the Parties hereto, no further or other uses or obstructions or diversions, whether temporary

or permanent, of boundary waters on either side of the line, affecting the natural level or flow of boundary waters on the other side of the line, shall be made except by authority of the United States or the Dominion of Canada within their respective jurisdictions and with the approval, as hereinafter provided, of a Joint Commission, to be known as the Inter-

national Joint Commission.

The foregoing provisions are not intended to limit or interfere with the existing rights of the Government of the United States on the one side and the Government of the Dominion of Canada on the other, to undertake and carry on governmental works in boundary waters for the deepening of channels, the construction of breakwaters, the improvement of harbours, and other governmental works for the benefit of commerce and navigation, provided that such works are wholly on its own side of the line and do not materially affect the level or flow of the boundary waters on the other, nor are such provisions intended to interfere with the ordinary use of such waters for domestic and sanitary purposes.

ABTICLE 4

The High Contracting Parties agree that, except in cases provided for by special agreement between them, they will not permit the construction or maintenance on their respective sides of the boundary of any remedial or protective works or any dams or other obstructions in waters flowing from boundary waters or in waters at a lower level than the boundary in rivers flowing across the boundary, the effect of which is to raise the natural level of waters on the other side of the boundary unless the construction or maintenance thereof is approved by the aforesaid International Joint Commission.

It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property

on the other.

ABTICLE 5

The High Contracting Parties agree that it is expedient to limit the diversion of waters from the Niagara River so that the level of lake Erie and the flow of the stream shall not be appreciably affected. It is the desire of both Parties to accomplish this object with the least possible injury to invest-

ments which have already been made in the construction of power plants on the United States' side of the river under grants of authority from the State of New York, and on the Canadian side of the river under licenses authorized by the Dominion of Canada and the Province of Ontario.

So long as this Treaty shall remain in force, no diversion of the waters of the Niagara River above the Falls from the natural course and stream thereof shall be permitted except for the purpose and to the extent hereinafter provided.

The United States may authorize and permit the diversion within the State of New York of the waters of the said river above the Falls of Niagara, for power purposes, not exceeding in the aggregate a daily diversion at the rate of 20,000 cubic

feet of water per second.

The United Kingdom, by the Dominion of Canada, or the Province of Ontario, may authorize and permit the diversion within the Province of Ontario of the waters of said river above the Falls of Niagara for power purposes, not exceeding in the aggregate a daily diversion at the rate of 36,000 cubic feet of water per second.

The prohibitions of this Article shall not apply to the diversion of water for sanitary or domestic purposes, or for the

service of canals for the purposes of navigation.

ARTICLE 6

The High Contracting Parties agree that the St. Mary and Milk Rivers and their Tributaries (in the State of Montana and the Provinces of Alberta and Saskatchewan) are to be treated as one stream for the purposes of irrigation and power, and the waters thereof shall be apportioned equally between the two countries, but in making such equal apportionment more than half may be taken from one river and less than half from the other by either country so as to afford a more beneficial use to each. It is further agreed that in the division of such waters during the irrigation season, between the 1st of April and 31st of October, inclusive, annually, the United States is entitled to a prior appropriation of 500 cubic feet per second of the waters of the Milk River, or so much of such amount as constitutes three-fourths of its natural flow, and that Canada is entitled to a prior appropriation of 500 cubic feet per second of the flow of St. Mary River, or so much of such amount as constitutes three-fourths of its natural flow

The channel of the Milk River may in Canada be used at the convenience of the United States for the conveyance, while passing through Canadian territory, of waters diverted from the St. Mary River. The provisions of Article 2 of this Treaty shall apply to any injury resulting to property in Canada from the conveyance of such waters through the Milk River.

The measurement and apportionment of the water to be used by each country shall from time to time be made jointly by the properly constituted reclamation officers of the United States and the properly constituted irrigation officers of His Majesty under the direction of the International Joint Com-

mission.

ARTICLE 7

The High Contracting Parties agree to establish and maintain an International Joint Commission of the United States and Canada composed of six Commissioners, three on the part of the United States appointed by the President thereof, and three on the part of the United Kingdom appointed by His Majesty on the recommendation of the Governor in Conncil of the Dominion of Canada.

ABTICLE 8

This International Joint Commission shall have jurisdiction over and shall pass upon all cases involving the use or obstruction or diversion of the waters with respect to which under Articles 3 and 4 of this Treaty the approval of this Commission is required, and in passing upon such cases the Commission shall be governed by the following rules and principles which are adopted by the High Contracting Parties for this purpose:—

The High Contracting Parties shall have, each on its own side of the boundary, equal and similar rights in the use of

the waters hereinbefore defined as boundary waters.

The following order of precedence shall be observed among the various uses enumerated hereinafter for these waters, and no use shall be permitted which tends materially to conflict with or restrain any other use which is given preference over it in this order of precedence—

1. Uses for domestic and sanitary purposes;

2. Uses for navigation, including the service of canals for the purposes of navigation;

3. Uses for power and for irrigation purposes.

The foregoing provisions shall not apply to or disturb any existing uses of boundary waters on either side of the boun-

dary.

The requirement for an equal division may in the discretion of the Commission be suspended in cases of temporary diversions along boundary waters at points where such equal division can not be made advantageously on account of local conditions, and where such diversion does not diminish elsewhere the amount available for use on the other side.

The Commission in its discretion may make its approval in any case conditional upon the construction of remedial or protective works to compensate so far as possible for the particular use or diversion proposed, and in such cases may require that suitable and adequate provision, approved by the Commission, be made for the protection and indemnity against injury of any interests on either side of the boundary.

In cases involving the elevation of the natural level of waters on either side of the line as a result of the construction or maintenance on the other side of remedial or protective works or dams or other obstructions in boundary waters or in waters flowing therefrom or in waters below the boundary in rivers flowing across the boundary, the Commission shall require, as a condition of its approval thereof, that suitable and adequate provision, approved by it, be made for the protection and indemnity of all interests on the other side

of the line which may be injured thereby.

The majority of the Commissioners shall have power to render a decision. In case the Commission is evenly divided upon any question or matter presented to it for decision, separate reports shall be made by the Commissioners on each side to their own Government. The High Contracting Parties shall thereupon endeavour to agree upon an adjustment of the question or matter of difference, and if an agreement is reached between them, it shall be reduced to writing in the form of a Protocol, and shall be communicated to the Commissioners, who shall take such further proceedings as may be necessary to carry out such agreement.

ARTICLE 9

The High Contracting Parties further agree that any other questions or matters of difference arising between them involving the rights, obligations, or interests of either in relation to the other or to the inhabitants of the other, along the common frontier between the United States and the Dominion of Canada, shall be referred from time to time to the International Joint Commission for examination and report, whenever either the Government of the United States or the Government of the Dominion of Canada shall request that such

questions or matters of difference be so referred.

The International Joint Commission is authorized in each case so referred to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

Such reports of the Commission shall not be regarded as decisions of the questions or matters so submitted either on the facts or the law, and shall in no way have the character

of an arbitral award.

The Commission shall make a joint report to both Governments in all cases in which all or a majority of the Commissioners agree, and in case of disagreement the minority may make a joint report to both Governments, or separate reports to their respective Governments.

In case the Commission is evenly divided upon any question or matter referred to it for report, separate reports shall be made by the Commissioners on each side to their own

Government.

ARTICLE 10

Any questions or matters of difference arising between the High Contracting Parties involving the rights, obligations, or. interests of the United States or of the Dominion of Canada either in relation to each other or to their respective inhabitants, may be referred for decision to the International Joint Commission by the consent of the two Parties, it being understood that on the part of the United States any such action will be by and with the advice and consent of the Senate, and on the part of His Majesty's Government with the consent of the Governor-General in Council. In each case so referred, the said Commission is authorized to examine into and report upon the facts and circumstances of the particular questions and matters referred, together with such conclusions and recommendations as may be appropriate, subject, however, to any restrictions or exceptions which may be imposed with respect thereto by the terms of the reference.

A majority of the said Commissioners shall have power to render a decision or finding upon any of the questions or matters so referred.

If the said Commission is equally divided, or otherwise unable to render a decision or finding as to any questions or matters so referred, it shall be the duty of the Commissioners to make a joint report to both Governments, or separate reports to their respective Governments, showing the different conclusions arrived at with regard to the matters or questions so referred, which questions or matters shall thereupon be referred for decision by the High Contracting Parties to an Umpire chosen in accordance with the procedure prescribed in the fourth, fifth, and sixth paragraphs of article 45 of The Hague Convention for the pacific settlement of international disputes, dated October 18, 1907. Such Umpire shall have power to render a final decision with respect to those matters and questions so referred on which the Commission failed to agree.

ABTICLE 11

A duplicate original of all decisions rendered and joint reports made by the Commission shall be transmitted to and filed with the Secretary of State of the United States and the Governor-General of the Dominion of Canada, and to them shall be addressed all communications of the Commission.

ARTICLE 12

The International Joint Commission shall meet and organize at Washington promptly after the members thereof are appointed and when organized the Commission may fix such times and places for its meetings as may be necessary, subject at all times to special call or direction by the two Governments. Each Commissioner, upon the first joint meeting of the Commission after his appointment, shall, before proceeding with the work of the Commission, make and subscribe a solemn declaration in writing that he will faithfully and impartially perform the duties imposed upon him under this Treaty, and such declaration shall be entered on the records of the proceedings of the Commission.

The United States and Canadian sections of the Commission may each appoint a Secretary, and these shall act as

joint Secretaries of the Commission at its joint sessions, and the Commission may employ engineers and clerical assistants from time to time as it may deem advisable. The salaries and personal expenses of the Commission and of the Secretaries shall be paid by their respective Governments, and all reasonable and necessary joint expenses of the Commission, incurred by it, shall be paid in equal moieties by the

High Contracting Parties.

The Commission shall have power to administer oaths to witnesses, and to take evidence on oath whenever deemed necessary in any proceeding, or inquiry, or matter within its jurisdiction under this Treaty, and all parties interested therein shall be given convenient opportunity to be heard, and the High Contracting Parties agree to adopt such legislation as may be appropriate and necessary to give the Commission the powers above mentioned on each side of the boundary, and to provide for the issue of subpoenas and for compelling the attendance of witnesses in proceedings before the Commission. The Commission may adopt such rules of procedure as shall be in accordance with justice and equity, and may make such examination in person and through agents or employes as may be deemed advisable.

ARTICLE 13

In all cases where special agreements between the High Contracting Parties hereto are referred to in the foregoing Articles, such agreements are understood and intended to include not only direct agreements between the High Contracting Parties, but also any mutual arrangement between the United States and the Dominion of Canada expressed by concurrent or reciprocal legislation on the part of Congress and the Parliament of the Dominion.

ARTICLE 14

The present Treaty shall be ratified by His Britannic Majesty and by the President of the United States of America, by and with the advice and consent of the Senate thereof. The ratifications shall be exchanged at Washington as soon as possible, and the Treaty shall take effect on the date of the exchange of its ratifications. It shall remain in force for five years, dating from the day of exchange of ratifications, and

thereafter until terminated by twelve months' written notice

given by either High Contracting Party to the other.

In faith whereof the respective Plenipotentiaries have signed this Treaty in duplicate and have hereunto affixed their seals.

Done at Washington, the 11th day of January, in the year

of our Lord one thousand nine hundred and nine.

(L. S.) JAMES BRYCE (L. S.) ELIHU ROOT

The above Treaty was approved by the United States' Senate on the 3rd March, 1909, with the following Resolutions:—

Resolved,—That the Senate advise and consent to the ratification of the Treaty between the United States and Great Britain, providing for the settlement of international difference between the United States and Canada, signed on the 11th day of January, 1909.

Resolved further (as a part of this ratification),—That the United States approves this Treaty with the understanding that nothing in this Treaty shall be construed as affecting, or changing, any existing territorial, or riparian rights in the water, or rights of the owners of lands under water, on either side of the International Boundary at the rapids of the St. Mary's River at Sault Ste. Marie, in the use of the waters flowing over such lands, subject to the requirements of navigation in boundary waters and of navigation canals, and without prejudice to the existing right of the United States and Canada, each to use the waters of the St. Mary's River, within its own territory; and further, that nothing in this Treaty shall be construed to interfere with the drainage of wet, swamp, and overflowed lands into streams flowing into boundary waters, and that this interpretation will be mentioned in the ratification of this Treaty as conveying the true meaning of the Treaty, and will, in effect, form part of the Treaty.

PROTOCOL OF EXCHANGE.

On proceeding to the exchange of the ratifications of the treaty signed at Washington on January 11, 1909, between Great Britain and the United States, relating to boundary waters and questions arising along the boundary between the

United States and the Dominion of Canada, the undersigned plenipotentiaries, duly authorized thereto by their respective Governments, hereby declare that nothing in this treaty shall be construed as affecting, or changing, any existing territorial, or riparian rights in the water, or rights of the owners of lands under water, on either side of the international boundary at the rapids of the St. Mary's river at Sault Ste. Marie, in the use of the waters flowing over such lands, subject to the requirements of navigation in boundary waters and of navigation canals, and without prejudice to the existing right of the United States and Canada, each to use the waters of the St. Mary's river, within its own territory; and further, that nothing in this treaty shall be construed to interfere with the drainage of wet, swamp, and overflowed lands into streams flowing into boundary waters, and also that this declaration shall be deemed to have equal force and effect as the treaty itself and to form an integral part thereof.

The exchange of ratifications then took place in the usual

form.

In witness whereof they have signed the present Protocol of Exchange and have affixed their seals thereto.

Done at Washington this 5th day of May, one thousand nine hundred and ten.

JAMES BRYCE (SEAL)
PHILANDER C. KNOX (SEAL)

^{*}The British ratification of this further Instrument was deposited with the United States Government July 23, 1910.

63d Congress, 2d Session. HOUSE OF REPRESENTATIVES.

Document No. 762.

FINAL REPORT, WATERWAY FROM LOCKPORT, ILL., TO THE MOUTH OF THE ILLINOIS RIVER.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, FINAL REPORT BY A SPECIAL BOARD OF ENGINEERS UPON WATERWAY FROM LOCKPOBT, ILL, BY WAY OF THE DES PLAINES AND ILLINOIS RIVERS, TO THE MOUTH OF SAID ILLINOIS RIVER, AND CERTAIN RELATED SUBJECTS.

February 20, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT, Washington, February 18, 1914.

The Speaker of the House of Representatives.

Sir: I have the honor to transmit herewith a letter from the Acting Chief of Engineers, United States Army, dated 17th instant, together with copy of final report by a special board of engineers, dated August 15, 1913, with maps, upon waterway from Lockport, Ill., by way of the Des Plaines and Illinois Rivers, to the mouth of Illinois River, the construction of dams at or near Jefferson Barracks and Commerce, and certain related subjects, made in compliance with the provisions of the river and harbor act approved June 25, 1910.

Very respectfully,

LINDLEY M. GARRISON,

Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, February 17, 1914.

From: The Chief of Engineers, United States Army.

To: The Secretary of War.

Subject: Waterway from Lockport, Ill., by way of the Des Plaines and Illinois Rivers to the mouth of Illinois River.

1. There is submitted herewith, for transmission to Congress, final report, dated August 15, 1913, with maps, by a special board appointed pursuant to the requirements of the river and harbor act approved June 25, 1910, to consider and report upon a waterway from Lockport, Ill., by way of the Des Plaines and Illinois Rivers to the mouth of Illinois River, the construction of dams at or near Jefferson Barracks and Commerce,

and certain related subjects.

2. Under date of November 1, 1910, the special board submitted a preliminary report, which is printed in House Document No. 1061, Sixty-first Congress, third session, and under date of January 23, 1911, it submitted a further report, printed in House Document No. 1374, Sixty-first Congress, third session, covering five of the nine questions specifically mentioned in the act. Attention is invited to these reports for detailed information regarding the project recommended for the construction of this waterway. The subjects treated in the present report of the special board include such measures as may be required to properly preserve the levels of the Great Lakes, the influence on volume and height of waters in the Mississippi River below Cairo, the effect upon the climate of the Lake States by a change in the natural currents of Lake Michigan, and the improvement of the Mississippi River between the mouth of the Illinois River and the mouth of the Ohio River by the construction of a dam at or near Jefferson Barracks. and a dam at or near Commerce, and the development of water power incidentally created by such dams.

3. The special board finds that the diversion of 10,000 cubic feet of water per second through the Chicago Drainage Canal would lower the water surface at mean lake level 0.465 foot in Lakes Huron and Michigan, 0.448 foot in Lake Erie, and 0.431 foot in Lake Ontario. It proposes the construction of summerged weirs in Niagara River to hold up the level of Lake Erie and submerged weirs in St. Clair River to hold

up the level of Lakes Michigan and Huron, at a total estimated cost of \$475,000, with \$15,000 annually for maintenance. The influence on the volume of the Mississippi River due to any diversion from Lake Michigan will be an increase approxi-

mately equal to the amount of water diverted.

4. The effect upon gauge height will be small, even at low stages, and at high stages it would scarcely be appreciable and of no importance. The effect on the climate of the Lake States, caused by the diversion of 10,000 second-feet of water through the Chicago Drainage Canal, whether beneficial or injurious, would be so small that it could not be measured by the most delicate instruments. The special board reports that the construction of dams at or near Jefferson Barracks and Commerce is not necessary for the execution of existing projects for the Illinois and Mississippi Rivers, nor of the projects recommended in the partial report printed in House Document No. 1374, Sixty-first Congress, third session. The work would be enormously expensive and not justified by resulting benefits to commerce and navigation, nor by the returns from water-power development.

5. The recommendations of the special board are contained in the partial report referred to above. It states that since the submission of that report nothing has developed to require any changes in the statements and conclusions therein

given.

6. This final report has been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated December 16, 1913, which gives a brief analysis of the entire investigation. The board concurs in general with the views of the special board, though with the information now available it is not prepared to indorse the discussion in all its details. Subject to certain conditions fully explained in its report, the board recommends the adoption of the project presented by the special board, which involves an original outlay by the United States of \$1,050,000 for the Illinois River and \$3,710,000 for the Mississippi River, or a total of \$4,760,000 for a navigable channel 8 feet deep from Utica to St. Louis.

Edw. Burb, Colonel, Corps of Engineers, Acting Chief of Engineers.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS.

[Second Indorsement.]

BOARD OF ENGINEERS FOR RIVERS AND HARBORS,

December 16, 1913.

To the Chief of Engineers, United States Army:

1. The Board of Engineers for Rivers and Harbors has had under consideration the final report of the special board of engineers, submitted pursuant to the following item contained in section 1 of the river and harbor act approved June

25, 1910:

For the construction of a waterway from Lockport, Ill., by way of the Desplaines and Illinois Rivers to the mouth of said Illinois River, \$1,000,000. The Secretary of War shall appoint a board of five members, to be composed of four engineer officers of the Army and one civil engineer taken from civil life. The president of the board of five members authorized under act of March 2, 1907, to examine the Mississippi River below St. Louis and report to Congress on the project of a 14-foot channel, shall be a member of and president of the board herein provided for. Said board shall report upon the feasibility of such waterway, and the most advisable depth and dimensions therefor, in case the same is recommended; also upon such measures as may be required to properly preserve the levels of the Great Lakes and to compensate, so far as practicable for the diminished level in said lakes and the connecting waters thereof by reason of any diversion of water from Lake Michigan for the maintenance of the proposed waterway herein described, or diversion for any other purpose and further, also, upon the influence on volume and height of waters in the Mississippi River below Cairo; and further, also, as to the effect upon the climate of the Lake States by a change in the natural currents of Lake Michigan. The board shall, after full conference with the authorized agency of the State of Illinois, submit a report upon the extent to which the United States may properly co-operate with the State of Illinois in securing the construction of a navigable waterway from Lockport to the mouth of the Illinois River in conjunction with the development of water power by said State

between Lockport and Utica, for which the people of the State of Illinois have authorized their general assembly to appropriate \$20,000,000; the report shall state the extent and character of the cooperation recommended and the conditions considered necessary in connection therewith to fully protect the interests of the United States. Should the board consider cooperation to be advisable, the report herein called for shall include plans and estimates of cost of the work recommended to be done by the United States alone or in cooperation with the State of Illinois; and until these plans and estimates have been submitted and a project for the improvement adopted by Congress the appropriation of \$1,000,000 herein made shall not be available for expenditure. The board also shall consider and report upon the improvement of the Mississippi between the mouth of the Illinois River and the mouth of the Ohio River by the construction of a dam at or near Jefferson Barracks and a dam at or near Commerce, and the development of water power incidentally created by such dams. In the perforamnce of its duties the board may consider all reports heretofore made: and the force, plant, and records of the Mississippi River Commission and the several engineer districts between Chicago and Cairo shall be available for the use of the board. The members of the board herein authorized shall be entitled to compensation at the rate of \$6,000 per annum, but the official salary of any officer appointed on said board from the Engineer Corps of the Army shall be deducted from the compensation provided for in this act. For salaries and expenses of said board, including all necessary clerical and other personal services, there is hereby appropriated the sum of \$50,000. The reports herein called for shall be submitted to the Chief of Engineers not later than November 1, 1910, reviewed by the Board of Engineers for Rivers and Harbors, and submitted to Congress not later than the first Monday in December. 1910.

2. Complying with the requirements of the above item, the special board under date of November 1, 1910, submitted a preliminary report outlining the steps being taken to procure the necessary data, and under date of January 23, 1911, it submitted a further report covering five of the nine questions specifically mentioned in the act. The former report is printed in House Document No. 1061, Sixty-first Congress, third ses-

sion, and the latter in House Document No. 1374 of the same Congress and session. The report now under consideration covers the remaining four questions, but for convenience of reference, a summary of the entire investigation is given below.

I. FEASIBILITY OF THE WATERWAY.

3. In the valley of the Des Plaines and upper Illinois Rivers, excellent foundations for locks are available; the lower Illinois has a gentle slope, so that any reasonable depth can be obtained by dredging, and the present diversion of water from Lake Michigan through the Chicago Drainage Canal is more than sufficient for navigation purposes. It is therefore the opinion of the special board that the waterway from Lockport to the mouth of the Illinois River is feasible.

II, THE MOST ADVISABLE DEPTH AND DIMENSIONS FOR THE WATERWAY

In determining the most advisable depth for the waterway, the special board gives consideration to the character, origin, and destination of the probable commerce, and the type and dimensions of the vessels best suited to handle the traffic. It states that if the waterway is to be used by vessels capable of navigating the ocean and the Great Lakes, it should be given a depth suitable for the economic carriers now used on those bodies of water, which would fix the depth at not less than 24 feet; but if it is to be constructed for vessels adapted to river traffic, navigation does not require its depth to exceed 9 feet. A depth of 14 feet, which has been frequently urged for this waterway, is greater than necessary for river navigation and entirely insufficient for either lake or ocean vessels. A uniform depth on the Mississippi and its leading tributaries will be far more beneficial to the navigation interests of the United States than a main channel of great depth with shallow feeders. As a channel of 8 feet depth is now maintained from Cairo to St. Louis, and can be extended from St. Louis to Utica, on the Illinois River, at relatively small cost, business caution dictates that a waterway of this depth be obtained and tested before entering upon enormously expensive projects of questionable utility.

5. The special board considers a bottom width of 160 feet in canal and 200 feet in the open river above the mouth of the Illinois sufficient for a channel of 8 or 9 feet available depth.

For safety and ease of navigation, the channel should be excavated to 11 feet in rock cuts and canals, and the locks should be given 11 feet depth, 80 feet width, and 600 feet usable length. A waterway of these dimensions would have a capacity exceeding 100,000,000 tons per annum.

III. CO-OPERATION WITH THE STATE OF ILLINOIS.

6. A project has been presented by the State of Illinois which contemplates the development of water power at four sites between Lockport and Utica, and the improvement of navigation by the construction of five large locks, 80 by 900 feet in horizontal dimensions, with 24 feet depth on their miter sills. This project proposes the utilization for power purposes of the water which may flow through the Chicago Drainage Canal and contemplates an ultimate channel depth of 24 feet for navigation purposes, though the estimates, amounting to approximately \$20,000,000, provide for 24 feet only to Brandon Bridge and for 14 feet below. The special board states that the waterway proposed is more than sufficient for any probable navigation. It believes that the General Government will fully cooperate with the State in a waterway from Lockport to the mouth of the Illinois River if it assumes charge of the State structures at Henry and Copperas Creek, and enlarges the existing channel in the Illinois River below Utica to suitable dimensions.

IV. CONDITIONS NECESSABY IN CONNECTION WITH COOPERATION TO FULLY PROTECT THE INTERESTS OF THE UNITED STATES.

7. The special board states that a primary condition of any cooperation between the United States and the State of Illinois should be the acceptance in perpetuity of full responsibility by the State of Illinois or its agencies for all damages by changes in lake levels, including cost of compensating works, and for all damages to riparian owners, and the State should transfer to the United States the locks and the control of the new waterway thus created so far as needed by navigation, and the locks and dams at Henry and Copperas Creek on the Illinois River. With such a transfer the obligations of the State of Illinois to the United States with reference to the maintenance of the Illinois and Michigan Canal may be considered as adequately fulfilled, and any equities of the United

States in the rights of way and other properties of this canal should be transferred by the United States to the State of Illinois. The special board believes that should the State of Illinois be unable to complete the locks suggested by the board or the bridges required by navigation, the United States might then properly undertake to complete these parts of the project.

V. PLANS AND ESTIMATES OF THE COST OF WORK RECOMMENDED TO BE DONE BY THE UNITED STATES.

The existing Federal project for the improvement of the Illinois River, adopted in 1880, together with the existing State project, provides for a 7-foot slackwater navigation from Utica to its mouth, which has already been obtained by dredging and by the construction of four dams, with locks 350 feet long and 75 feet wide. The opening of the Chicago Drainage Canal in 1900, however, added an increased volume of water, which has raised the level of low water so that 8 feet can be carried to Grafton, provided the upper miter sills at Henry and Copperas Creek are lowered about 1 foot, the crests of the dams are restored at the heights to which they were oirginally constructed, and portions of the pools deepened slightly by dredging. The estimate of cost is as follows: Excavation in pools and in river below Kampsville. . \$887,545 Lowering miter sills and reconstructing gates..... 60,000 Restoring crest of Kamspville Dam..... 7,000

95,455

Miscellaneous and contingencies, 10 per cent.....

VI. SUCH MEASURES AS MAY BE REQUIRED TO PROPERLY PRESERVE THE LEVELS OF THE GREAT LAKES, ETC.

9. The investigations and studies of the special board show that the diversion of water from the Lakes lowers the levels progressively in proportion to the amount so diverted, the full effect not being observable for some time; and that for the 10,000 second-feet diverted through the Chicago Drainage Canal, at mean lake level, the water surface will be lowered in Lakes Huron and Michigan 0.465 foot; in Lake Erie, 0.448 foot; in Lake Ontario, 0.431 foot. Such lowering would materially affect the carrying capacity of the large freight vessels, estimated at 88 tons per inch of draft, and would cause a loss on American vessels alone at the lowest estimate of

\$1,000,000 per annum.

Three methods for compensating for such diversion have been considered by the special board: (1) By the construction of submerged weirs with arbitrarily controllable sluices at the lower ends of the Lakes; (2) by reducing the area of the natural outlets by the construction of fixed contraction works therein: (3) by dredging harbors and connecting channels. The investigations of the board show with certainty that the result of diversion of water through a new outlet is a lowering of Lake level. The effect of the great storage capacity of the lakes and of the natural fluctuations of level due to natural causes, such as the varying amount of rainfall and the varying amount and direction of wind pressures, is such that the absolute level at a given time at any given place can not be predicted, and human wisdom is inadequate to regulate a variation of discharge through the outlet in such a manner as to produce a definite desired result. Method No. 1 therefore must be classed as impracticable. Compensation by dredging is practicable, but on account of the extensive areas involved, this method would be unduly costly. Of the three methods, the second only is therefore favorably considered. The special board proposes to hold up the level of Lake Erie by the construction of three submerged wiers in Niagara River, at an estimated cost of \$150,000, and that of Lakes Michigan and Huron by submerged weirs in St. Clair River, at an estimated cost of \$325,000, the total for compensating works being \$475,000, with \$15,000 annually for maintenance.

VII. THE INFLUENCE ON VOLUME AND HEIGHT OF WATERS IN THE MISSISSIPPI RIVER BELOW CAIRO.

- 11. The influence on the volume of the Mississippi River due to any diversion from Lake Michigan will be an increase approximately equal to the amount of water diverted. The effect upon gauge height will be small even at low stages, and at high stages it would scarcely be appreciable and not of any importance.
- VIII. THE EFFECT UPON THE CLIMATE OF THE LAKE STATES BY A CHANGE IN THE NATURAL CURRENTS OF LAKE MICHIGAN.
- 12. After extensive investigation and discussion of this subject the conclusion is reached that the effect on the climate of the Lake States, caused by the diversion of 10,000 second-feet of water through the Chicago Drainage Canal, whether beneficial or injurious, would be so small that it could not be measured by the most delicate instruments.
- IX. UPON THE IMPROVEMENT OF THE MISSISSIPPI RIVER BETWEEN THE MOUTH OF THE ILLINOIS-RIVER AND THE MOUTH OF THE OHIO RIVER BY THE CONSTRUCTION OF A DAM AT OR NEAR JEFFERSON BARRACKS AND A DAM AT OR NEAR COMMERCE, AND THE DEVELOPMENT OF WATER POWER INCIDENTALLY CREATED BY SUCH DAMS.
- 13. The construction of such dams is not necessary for the execution of existing projects for the Illinois and Mississippi Rivers or of the projects recommended in the partial report printed in House Document No. 1374, Sixty-first Congress, third session. The special board reports that the work would be enormously expensive and not justified by resulting benefits to commerce and navigation or by the returns from water-power development.

CONCLUSIONS,

14. After due consideration of the reports of the special board the Board of Engineers for Rivers and Harbors concurs in general with the views and conclusions expressed therein. With the information now available, it is not prepared to indorse certain details of the discussions in the appendixes and elsewhere pertaining to the regulation of the level of Lake Superior, the regulation of the day and night

discharge at Niagara Falls, and the estimates of cost for the dams across the Mississippi River. But inasmuch as this difference of opinion on these points does not affect the final conclusions, the board believes that nothing would be gained at this time by pursuing its investigation further. The board concurs fully with the general conclusions expressed by the special board in its final report, but differs slightly from those given in its preceding report. In this connection attention is invited to the following statements made by the Board of Engineers for Rivers and Harbors in its report of January 30, 1911, printed in House Document No. 1374, Sixty-first Congress, third session:

It does not concur with the view of the special board that the United States should assume that part, if any, of the cost that is in excess of \$20,000,000 for constructing the portion of the waterway between Lockport and Utica. Moreover, it suggests that the amount of diversion to be permitted from Lake Michigan should be determined, if

practicable, before the project is undertaken.

It is understood that the sanitary district of Chicago and the State expect to develop considerable water power on that portion of the waterway between Chicago and Utica. As it is proposed that the navigable channel between these points shall be built without cost to the United States, it is believed that the General Government should relinquish to these local agencies any rights that it may have in the power to be thus developed. It does not appear that there is any question of water power, flood control, or other matter that can be coordinated with that portion of the work to be done by the United States for the improvement of navigation, so as to lessen the cost and compensate the Government for its expenditures made in the interest of navigation.

In conclusion it is recommended that the work proposed by the special board for the United States in the Illinois River be not undertaken until the Secretary of War has received satisfactory assurance from the State of Illinois that the State will build that portion of the waterway from Lockport to Utica without cost to the United States, and in accordance with plans to be approved by him; and, further, until the interests of the United States have been satisfactorily safeguarded as indicated by the special board, viz., that the State of Illi-

nois, or its agencies, shall assume entire responsibility in perpetuity for all damages by changes in lake levels incident to the work, including cost of compensating works, and for all damages to riparian owners along the proposed waterway from Lake Michigan to the mouth of the Illinois River, and that the State shall transfer to the United States the locks and the control of the new waterway thus created so far as needed for navigation, and the locks and dams at Henry and Copperas Creek on the

Illinois River.

It is the distinct recommendation of the Board of Engineers for Rivers and Harbors that the term "control of the new waterway thus created so far as needed for navigation" shall be interpreted to include such control of the use of water for power purposes as shall be necessary to insure the conditions of flow required for navigation. Further, the board believes that the total volume of water to be diverted from the natural discharge channels of the Lakes should be definitely fixed by Congress; that a project, with estimate of cost, for works necessary to compensate for such diversion should be prepared to the satisfaction of the Chief of Engineers and the Secretary of War; that before any diversion is made beyond that at present existing, the State of Illinois shall transfer to the Secretary of War the funds necessary for such works as given by the approved estimate of cost: that the works shall be built by the United States with the funds so provided; and that the control and maintenance of such works shall be in and at the cost of the United States.

16. As indicated above, the work proposed by the special board involves an original outlay by the United States of \$1,050,000 for the Illinois River and \$3,710,000 for the Mississippi River, or a total of \$4,760,000, and provides for a navigable channel depth of 8 feet from Utica to St. Louis. The act ordering the investigation appropriated \$1,000,000 "for the construction of a waterway from Lockport, Ill., by way of the Des Plaines and Illinois Rivers to the mouth of said Illinois River," and provided that "until these plans and estimates have been submitted and a project adopted by Congress the appropriation of \$1,000,000 herein made shall not be available for expenditure." If the project be adopted by Congress, this conditional appropriation should be made available for the improvement as a whole, and subsequent appropriations should be made with a view to completion of the work in four years. The Board of Engineers for Rivers

and Harbors recommends the adoption of the project under the conditions stated above.

For the Board:

W. M. BLACK, Colonel, Corps of Engineers, Senior Member of the Board.

FINAL REPORT BY A SPECIAL BOARD OF ENGINEERS ON WATERWAY FROM LOCKPORT, ILL., TO MOUTH OF ILLINOIS RIVER.

New York City, August 15, 1913.

From: A Special Board of Engineers.

To: The Chief of Engineers, United States Army.

Subject: Report on waterway from Lockport Ill., to the mouth of Illinois River, and on certain related subjects.

The Board of Engineers appointed by the Secretary of War September 8, 1910, in Special Orders, No. 43, Office of the Chief of Engineers, for the consideration of a waterway from Lockport, Ill., by way of the Des Plaines and Illinois Rivers, to the mouth of the said Illinois River, in its reports of November 1, 1910, and January 23, 1911, has discussed certain of the questions referred to it—namely: I, Feasibility of the waterway; II, the most advisable depths and dimensions for the waterway; III, cooperation with the State of Illinois; IV, conditions necessary in connection with cooperation to fully protect the interests of the United States, and V, plans and estimates of the cost of work recommended to be done by the United States. Since the submission of the above reports nothing has developed to require any changes in the statements and conclusions therein given. For convenience of reference these reports are attached hereto marked as Appendixes E and F.

The necessary additional investigations having been completed, the results of which are shown in Appendixes A, B, C, and D, the board now has the honor to submit the following report upon the remaining questions submitted to it

for consideration:

VI. Such measures as may be required to properly preserve the levels of the Great Lakes and to compensate, so far as practicable, for the diminished level in said lakes and the connecting waters thereof by reason of any diversion of water from Lake Michigan for the maintenance of the proposed waterway or for any other purpose.

This subject is specially discussed in Appendix A.

Since 1895 the United States Lake Survey, under the direction of the Chief of Engineers, has made a systematic series of measurements of discharges in the St. Mary's, St. Clair, Detroit, Niagara, and St. Lawrence Rivers, to determine the relation which exists between the volumes of water discharged by these rivers and the levels of the lake surfaces. These discharge measurements have been numerous and demonstrate conclusively that there is a direct connection between the height of each lake and the volume of water discharged at its outlet.

For a change of 1 foot from the mean of the stages covered by the observations on each lake the discharge will vary as stated in Table I, and conversly the changes of level in feet, due to diversions from the natural outlets of varying

amounts, will be as shown in Table II.

TABLE I.

Lake.	Mean stage.1	Discharge at mean stage.	Change in discharge due to 1 foot change in level close to mean stage.
Superior	Feet. 601.80 680.35 571.96 244.60	Second- feet. 78,000 192,300 198,500 200,000	15,300 gauge at S. W. cannal pler. 21,500 Fort Gratiot gauge. Lake St. Clair normal. 22,300 Buffalo L. H. gauge. 23,300 Ogdensburg gauge. Discharge adjusted for effect of closure of Gut Channel in Galope Rapids, estimated to reduce existing discharges 9,000 cable feet per second below those formerty existing at the same stages.

Mean of range during discharge measurements.

TABLE II.—CHANGES OF LEVEL, IN FRET, DUE TO DIRECT DIVERSION OF AMOUNTS VARYING BETWEEN 1,000 AND 14,000 CUBIC FEET PER SECOND.

Poot Poot	1,000 qubic feet.	Foot. 0.046 131 130 281 281 281 282 487 487 483 484 719 784 850	Foot. 0.046 -009 -130 -130 -130 -222 -270 -225 -270 -235 -410 -466	Poot. 0.045 .000 .134 .179 .224 .250 .814 .839 .404 .448 .688 .838 .838	P 0.
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These changes are obscured by variations in the supply of water from rains, by evaporation, by the effects of winds, and by the obstruction of the outlets by ice, and due to the reservoir capacity of the different lakes the action will not be immediate. As shown in the report of the Lake Survey for 1904, page 4120, one-half of the ultimate fall of Lakes Michigan and Huron will occur in 1.46 years, and nine-tenths of the fall will be completed in 4.86 years. For Lake Erie 50 per cent. of the ultimate lowering will occur in 2.5 months and 90 per cent. in 8 months; for Lake Ontario, in 2.1 months and 7 months, respectively.

It is therefore evident that when the Lakes stand at mean lake level a diversion of 10,000 cubic feet per second from Lake Michigan through the Chicago Drainage Canal will ultimately produce a lowering of the water surface of Lakes Michigan and Huron and its connecting harbors and channels of 0.465 feet (5.58 inches), of Lake Erie of 0.448 feet (5.38 inches), and of Lake Ontario of 0.431 feet (5.16 inches); at lower stages the effect will be greater, due to the relatively

smaller area of the cross section of the outlets.

The largest lake freighters recently built carry over 80 short tons of freight for each inch of loaded draft, and an uncompensated Chicago diversion of 10,000 second-feet would cause a loss to each vessel of at least 446 tons in carrying capacity for each down trip through the channels connecting with Lakes Michigan and Huron. This, based upon 25 trips per season, with vessels returning light, means a loss of at least 11,150 tons per year, and at a freight rate of 55 cents per ton represents a monetary loss of at least \$6,000 per large vessel per year. During the season of 1912 there passed through the locks at Sault Ste. Marie over 72,000,000 tons of freight, the greater part of which was carried in vessels of such size as to be affected by any loss of depth caused by a Chicago diversion. The tonnage of 1913 bids fair to exceed the tonnage of 1912. The lowest estimate of the loss to American vessels alone that has been brought to the attention of the board is over \$1,000,000 per annum, and the loss will increase with the increase in the number and size of vessels.

It is evident therefore that any diversion with consequent lowering of lake levels will cause a direct financial loss to vessel owners and such a loss can be prevented only by the adoption of remedial measures. For this purpose three methods have been proposed. First, to regulate the level of the Lakes between fixed limits by the construction of sub-

merged weirs and adjustable sluices at the lower ends of the Lakes, and by this means not only to prevent the oscillations of lake levels which occur daily each season, but also to equalize the flow over a series of years. Second, to compensate for the diminished discharge by reducing the area of the natural outlets by construction of contraction works therein. Third, to restore the original depths of the harbors and con-

necting channels by dredging.

It is the opinion of the board that while it is feasible to raise the average surface of the Lakes to any desired elevation by means of weirs and sluices it will be exceedingly difficult and in many ways impracticable to regulate the oscillations of the Lakes to a greater extent than nature now does automatically. These oscillations arise from winds, from the relative amount of rainfall and evaporation, and from other natural causes, which man can neither control nor forsee. The effect of any attempted regulation will be local rather than general, and the local benefits will be offset by injuries elsewhere. The difficulties in regulating lake levels are fully discussed by the International Waterways Commission in House Document No. 779, Sixty-first Congress, second session, and a resume of the views expressed therein is given in Appendix A.

To restore the diminished levels in the Lakes by constructing contracting works in their outlets does not however present any serious difficulties. A careful discussion of the proper locations and dimensions of such works is also given

in Appendix A.

At the foot of Lake Ontario the closure of the Gut channel of the Galops Rapids by the Canadian Government has had the effect of raising the level of Lake Ontario an amount nearly equal to the computed lowering of the lake by a diversion of 10,000 second feet at Chicago, and no compensation is at present deemed necessary to restore former conditions in this lake.

In Appendix A it is proposed to diminish the outflow of Lake Erie by the construction of three submerged weirs in Niagara River in the vicinity of Squaw Island, which would average about 4.2 feet in height and would contain about 15,000 cubic yards of masonry. The estimated cost is \$150,000

To raise the level of Lakes Michigan and Huron submerged weirs are proposed in St. Clair River, covering 3 miles of river below the mouth of Black River at Port Huron. The

weirs as suggested in Appendix A have a height of from 5 to 6 feet above the river bed, contain about 65,000 cubic yards of material, and their estimated cost is \$325,000. It is computed that these weirs will increase the velocity of the water flowing over them slightly (from a mean of 3.28 feet to 3.89 feet per second), but, on the other hand, above the mouth of Black River the river slopes and velocities which are now excessive will be diminished, and navigation on the whole will be considerably benefited.

The Chicago diversion has no effect on Lake Superior.

Compensation for the loss of elevation on Lakes Michigan, Huron, and Erie, and their connecting waters, due to an assumed diversion from Lake Michigan of 10,000 second-feet, will by the plan above outlined involve an expenditure of about \$475,000, to which should be added an amount for the maintenance of the weirs, estimated at about \$15,000 per year, the total cost being much less than the cost of restoration of depths by dredging. It is the opinion of the board that while other plans have been proposed, compensation by fixed contraction works similar in general to those above described affords the cheapest and most satisfactory method of preserving the levels of the Great Lakes.

No estimates have been considered for compensating for the loss of depths in the St. Lawrence River, as such work is regarded as outside the scope of the duties of the board.

VII. The influence on volume and height of waters in the Mississippi River below Cairo.

This subject is specially discussed in Appendix B.

The influence on the volume of the Mississippi River due to any diversion from Lake Michigan will be an increase approximately equal to the amount of the diversion, since the losses due to evaporation and other causes will not be large, and at extreme high water the increase, due to a 5,000 second-foot diversion, will be less than one-third of 1 per cent. from Cario to the mouth of the river.

Except as increase in volume results in increase of gauge height or depth of water available for purposes of navigation, it will be of no importance within any limits of diversion

heretofore considered as permissible.

The effect of any diversion upon gauge height will always be small, and at the highest stages practically nothing, but the exact effect at any time or at any stage can not be determined, since this effect will be complicated or obscured by various other changes in the regimen of the river. An extended series of discharge observations of the Mississippi River was taken under the direction of the Mississippi River Commission from 1879 to 1885, at Columbus, Ky., below the mouth of the Ohio River; at Helena, Ark., below the mouth of the St. Francis River; at Arkansas City, Ark., at Wilsons Point, Miss., and at Hays Landing, below the mouths of the White and Arkansas Rivers; at Warrenton, Miss., below the mouth of the Yazoo River; at Red River Landing and at Carrollton, La. Mean discharge curves have been derived from these observations, and extended and checked by numerous observations made at later dates.

On plate 1 of Appendix B are shown the mean discharge curves at Columbus, Ky., Helena, Ark., Vicksburg (and Warrenton), Miss., and Red River Landing, La., and the curves of theoretical increase in gauge heights deduced from them. These curves show that the influence of a given diversion from Lake Michigan through the Chicago Drainage Canal upon the volume and height of the Mississippi River varies with the localities and at the same locality with every change in discharge and that in all cases the increase in gauge heights

will be small.

Assuming that increase in gauge height will not be accompanied by changes in cross section of the river or that its effect will not be otherwise obscured, the diagram indicates that at all four places considered it would require in discharge considerably exceeding 10,000 cubic feet per second to increase the gauge heights by 1 foot even at the lowest stages of the river; under similar assumption at stages corresponding to 40 feet at Columbus the curves indicate that it would require an increase of over 50,000 cubic feet per second to increase the gauge height 1 foot at Columbus, Helena, and Red River Landing, or over 5,000 cubic feet per second to affect the gauge height one-tenth of a foot. At higher stages the effect would be even less and it is evident that on extreme flood heights the effect of any permissible diversion would be trifling and would have no important bearing upon the heights of levees or other works designed to afford protection against floods.

But even these small increases of gauge heights are not an exact measure of the increase in depths which would result from an increase in the volume of the river. As the discharge increases, not only does the surface of the water rise, but that of the bars also. This subject was discussed by a former board, and it was shown by an extended series of observa-

tions that a rise of the river of 1 foot is accompanied by a rise of bar of not less than 6 inches. The rise of the bar occurs more slowly than the rise of the water surface, and as the river is continually fluctuating the full effect does not appear in the observations. Where a permanent addition is made to the discharge, the rise of the bar may more closely approach that of the water surface, but in any case the influence of the increase in discharge on navigable depths will

be insignificant.

The board has also shown in discussing the sixth subject that the effect of diverting 10,000 second-feet through the Chicago Drainage Canal from the Great Lakes will appreciably injure their navigability, and in its preceding report that such a diversion was not necessary to obtain either the 8 or 9 foot navigation recommended from Chicago to the mouth of the Illinois River. Since its last report it has been in conference with the authorities of the State of Illinois in reference to the advisability of removing the existing dams in the Illinois River. Even with the diversion of not more than 4,167 second-feet at present authorized, the board agrees with the State authorities that the dams could be removed and the desired channel depths obtained by dredging alone; but the project for obtaining channels of 8 and 9 feet depth, recommended by the board in the report of January 23, 1911, contemplates the fullest possible use of the work already done on the Illinois River, which has been improved to a depth of 7 feet. To remove the locks and dams, and thereafter obtain depths of 8 and 9 feet by dredging alone, will add greatly to the cost of the improvement.

If large amounts of water are to be admitted into the river, the removal of dams would reduce the damage to the valley from overflow from this discharge; but the board reiterates that a diversion exceeding 1,000 second-feet is not necessary for navigation purposes alone in the Illinois River, and that an added discharge will produce a slight and inadequate effect

on the Mississippi River.

The object of diverting 10,000 or more second-feet from Lake Michigan is not primarily to benefit navigation, but to dilute sewage and to create power, and the United States should not be burdened with the cost of protecting the low-lands of the Illinois Valley from overflow where such diversion and overflow are unnecessary for navigation alone.

VIII. The effect on the climate of the Lake States by a change in the natural currents of Lake Michigan.

This subject is specially discussed in Appendix C.

While the variations of the levels of the Great Lakes have been carefully studied for a long period on account of their effect on the depths of harbors and connecting channels, it is only during recent years that data have been collected relating to their temperature and currents. The information thus obtained is not only incomplete, but the conclusions derived therefrom by some observers are contradictory. To properly investigate the subject, the loard has therefore found it necessary to make a series of independent observations. A report on the results of these investigations is

given in Appendix C.

It has been quite generally believed that there exists in Lake Michigan a surface current flowing in a southerly direction along the Wisconsin shore and northerly along the State of Michigan, and that it is quite fixed in direction, particularly during the summer months, but the observations conclusively show that this belief is a popular fallacy, and that the surface currents, instead of being fixed in direction, are extremely variable. They tend to follow straight lines dependent on the direction of the winds and other conditions. With a wind blowing from a northerly direction, there is a tendency for a southerly surface flow of water on both the Wisconsin and Michigan shores, and when the wind blows from a southerly quadrant the currents on both shores tend to flow to the north. A westerly wind raises the water on the Michigan shore, and an easterly wind on the Wisconsin shore. Changes of level and of currents are also frequently produced by variations in barometric pressure.

The observations also show that the temperature of the surface water at any locality is affected by the direction of the wind. During the summer months at any locality where the wind is blowing on-shore the surface water is warmer than on the opposite side of the lake, and a change to an off-shore breeze will frequently reduce the temperature of the surface water at this locality from 10 to 15 degrees. This phenomenon is accounted for by the fact that the wind raises the water on the shore toward which it blows and depresses it on the opposite shore. Due to this disturbance of the equilibrium, there is a return flow, which does not occur on the surface, but at a considerable distance below it. Instead of

being in a southerly direction on one side of the lake and a northerly on the other, the path described by the waters is, on the surface, in the direction of the winds, and thence on the leeward shore, the current is directed toward the bottom of the lake, whence it flows at a great depth back to the windward side and finally up to the surface, thus completing the cycle.

While the temperature of the surface waters of the lakes varies from 32° F. during the winter months to nearly 80° in summer, the variations at 100 feet below the surface are within much narrower limits. In Lake Superior the temperature of the water at great depths appears to remain at approximately 39° during the entire year and on the other Great Lakes, at depths of 100 feet, does not exceed 50° F. during

the warmest weather.

The return subsurface currents are continually bringing the lower waters to the surface and affecting its temperature, making it cooler in summer and warmer in winter. They also retard the formation of ice, as they render it necessary to reduce a large volume of water approximately to the freez-

ing point before it congeals.

The effect of water on the temperature of the air passing over it is a function of the strength of the winds and the area and depth of the lake. Lake Michigan has an area of over 22,000 square miles. Its greatest length is 307 miles, its width 118 miles, and its maximum depth 870 feet. It exposes an enormous water surface to the action of winds, and its depth gives an immense volume to absorb or radiate heat. Moreover, it is connected to Lake Huron, which also has an area exceeding 22,000 square miles and a maximum depth of 750 feet, by a broad and deep channel, through which not infrequently there is a flow of over 2,000,000 cubic feet per second, and any material change of temperature in one lake will be transmitted to the other.

These, rather than lake currents, are the principal factors which affect the climate of the Lake States, and the diversion of any water through the Chicago Drainage Canal will primarily affect the climate only to the extent that it reduces the area or volume of the lake. As has been previously stated, the diversion of 10,000 second-feet will ultimately lower the level of the lake 5.58 inches. The reduction in volume or area of a lake 870 feet deep and having an area of 22,000 square miles, by a reduction in depth of this amount is in-

appreciable.

It may therefore be stated that the effect on the climate of the Lake States, caused by diverting 10,000 second-feet of water through the Chicago Drainage Canal, whether theoretically beneficial or injurious, would be so small that it could not be measured by the most delicate instruments.

IX. Upon the improvement of the Mississippi between the mouth of the Illinois River and the mouth of the Ohio River by the construction of a dam at or near Jefferson Barracks and a dam at or near Commerce and the development of water power incidentally created by such dams.

This question is specially discussed in Appendix D.

The existing projects for improving the navigation of the Mississippi River contemplate a channel 6 feet deep at low water from the mouth of the Illinois to St. Louis, and 8 feet deep from St. Louis to the mouth of the Ohio. These depths are ample for all existing river navigation. To provide for a reasonably prospective commerce this board, in its report dated January 23, 1911, House Document No. 1374, Sixty-first Congress, third session, recommends that an 8-foot channel be made from St. Louis up the Illinois River, thus affording a depth of 8 feet from the upper Illinois to the mouth of the Ohio, and that, should an increasing traffic demonstrate the necessity for additional facilities, a channel 9 feet deep be made. A depth of 8 or 9 feet, properly utilized, is sufficient for an enormous traffic.

The construction of the two dams referred to in the portion of the act of June 25, 1910, quoted above, is not necessary to create depths of 8 or 9 feet. The desired improvement may be made at a much less cost, by the simpler methods

of regulation and dredging.

The board is aware that a channel depth greater than 8 or 9 feet has been considered by some as desirable, and that a low-water channel depth of 14 feet or more has been advocated. Methods for obtaining a depth of 14 feet have been considered by a former board, whose report, published in House Document No. 50, Sixty-first Congress, first session, shows that even for this greater depth the method of regulation and dredging is preferable.

The present board concurs in the conclusions of the former board and is of the opinion that the construction of high dams is not the better method for securing such greater depth of channel, even should the latter ever become necessary, and that only an extremely low cost of the water power incidentally created by such dams can possibly warrant their construction.

To determine the best location for the upper one of the dams described in the act, a survey was made at the request of the board by the United States Engineer office at St. Louis to ascertain the depth of the rock at sites regarded as most advantageous. These rock borings are described in Appendix D. For the lower or Commerce dam the board uses the information procured by a former board, whose report is published as House Document No. 50, Sixty-first Congress, first session.

The least objectionable site for the St. Louis dam is at the foot of Stein street, where rock occurs within the low-water bed of the river at a general depth of about 77 feet, as shown in plate 1, Appendix D. East of the low-water bed some of the borings showed the rock to be at depths of over 119 feet below low water. (See plate 2, Appendix D.)

The site selected near Commerce is at Grays Point, near mile 137, below St. Louis, where, although the soundings show the rock of the river bed to range between 24 and 85 feet below low water, it is possible to found most of the dam on rock at the higher elevation. Accordingly, the difficulties of construction would be somewhat less than at the site of the proposed St. Louis dam.

In the discussion of the construction of these two dams, it seems desirable first to consider fully the details of the only plan that has, so far as we know, been seriously advocated. This is the plan of the consulting engineer of the Lakes to the Gulf Deep Waterway Association, which is quite fully described in Appendix D and in the papers accompaying the latter.

Briefly, this plan contemplates the construction of two dams, the upper one near St. Louis with crest at elevation 413, Memphis datum, the lower one near Commerce with crest at elevation 343, the dams to be substantially similar, each with 3,000 feet of fixed spillway in the form of "an equilateral slant" with vertex upstream and with "a bear-trap section" at right angles to the stream 1,000 feet long, with a range of 15 to 16 feet below fixed weir level. Each dam is figured to pass the bank-full discharge with a depth of 10 feet on the crest "and greater floods within desirable limits." Bank-full stage at St. Louis is about 30 feet above low water. The flood of 1903, which did an enormous amount of damages at

East St. Louis, was, at its maximum, 38 feet above low water, and the greatest recorded flood, that of 1844, 41.4 feet above low water.

This plan of the Lakes to the Gulf Deep Waterway Association proposes the development of power at St. Louis at all stages below the bank-full stage, and as greater floods are to be passed through the dam by means of bear-trap gates, the dam will at those higher stages create practically no head, and during such stages the power will fail. In 1883 the river was above the bank-full stage for 17 consecutive days, in 1892 for 36 consecutive days and again for 12 consecutive days, and in 1903 for 16 consecutive days. As a power proposition the proposed dam, without an auxiliary steam plant, is evidently not sufficiently trustworthy from a business point of view. Arrangements based upon the expectation of constantly securing power at anything like the maximum rate would eventually prove disappointing; while a steam auxiliary would necessarily have to be of capacity equal to the maximum estimated output of the proposed water power.

The effect of the proposed St. Louis dam upon flood elevations merits serious consideration. At the St. Louis site there are no falls or rapids such as generally suggest the feasibility of power development and permit the work to be done with relatively little or no changes of river stages. On the contrary, the general slope of the river near St. Louis is about six-tenths of a foot per mile, and as the low-water elevation at the St. Louis site is 385.6, a dam whose crest is at 413 would concentrate at this locality the fall of about 46 miles of river. With banks which, even now, are submerged during floods, it is readily apparent that, while the raising of the level of the water surface in the pool above the dam might be permissible during low water, the effect during

floods would be disastrous.

The Mississippi River in the vicinity of St. Louis has been extensively contracted by bridges and by works to improve the low-water channel and by levees constructed on reclaimed land. This contraction has already produced a dangerous increase in flood heights. In as thickly settled a country as surrounds St. Louis, a further increase in flood heights in the present contracted section, such as might be produced by a high dam, can not be permitted.

In House Document No. 772, Fifty-ninth Congress, first session, the Board of Engineers for Rivers and Harbors invites attention to the fact that the effect of confining a flood

such as that of 1844 in a channel 2,000 feet wide will require a mean velocity of 14 feet per second for the maximum discharge, estimated at 1,360,000 cubic feet per second, to pass through the present channel at the Eads Bridge with the water surface at an elevation of 45 feet above the zero of the gauge (the grade proposed for levees now under construction). Even if the flood should cause a scour to bedrock, a distance of some 20 feet below the present river bottom, a mean velocity of 8 feet would result. Either assumption appears less probable than a material further increase in flood heights.

It is our opinion that, before the power dam proposed by the Lakes to the Gulf Waterway Association could be permitted at this locality, the levee under construction around East St. Louis must be set back about 2,000 feet and all buildings and embankments which are in front of the new levee, not absolute necessities to transportation and which interfere with the run-off of water, be removed, or provision otherwise made for discharge of at last 400,000 second-feet more than

at present provided for.

It is impracticable to set back the levees of East St. Louis 2,000 feet and to remove all structures between the levees and the river. It is equally out of the question, within reasonable limits of cost and without obliterating the working head, to provide at the dam for an excess flow of 400,000 cubic feet per second. Consequently the construction of the dam under the plans advocated by the Lakes to the Gulf Waterway Association would expose the people of the vicinity to great disaster.

While power can be created at low heads, in view of the high probable cost of construction of the dam and power house, its economical development at this locality appears to demand a low-water head of at least 25 feet. At Keokuk, where foundation conditions were most favorable and the cost of construction certainly far less than it would be at St. Louis, a head of 40 feet was regarded as necessary. The development of power in commercially available form requires a regulated output of alternating electrical current, to the production of which a substantially uniform speed of revolution of the electric generators is essential. This uniformity of speed can best be secured when there is little or no variation in the head of water on the turbines. Moderate reduction in the normal head reduces the output of current while maintaining uniformity of speed. Greater reduction of head

makes it impossible to maintain the required speed of revolution and then the output of alternating current ceases. The extreme variation which is usually permitted occurs when the minimum head is 55 to 60 per cent. of the maximum head, but by appropriate design the range may be extended, permitting the minimum head to be 40 to 45 per cent. of the maximum, accompanied, however, by a considerable loss of efficiency at the high heads which correspond to low water. In the case of the dam proposed by the Lakes to the Gulf Deep Waterway Association, the design does not contemplate the development of power at stages above the bank-full stage. At and for some distance below the latter stage the head will be below the permissible limits, so that considerable dredging below the dam will be nesessary in order to permit power to be developed even to this partial and unsatisfactory degree. Considered alone upon the basis of the power to be developed, the proposed dam is therefore not satisfactory, and the dredging which is necessary to make it available up to the bank-full stage will not only add greatly to the cost, but will also be attended with unusual difficulties.

As is well known, the Mississippi River at St. Louis carries large quantities of sediment, most of which is derived from the Missouri River. The amount discharged by the Missouri River during the year 1879, a year of extremely low water, was estimated by the president of the Missouri River commission as about 400,000,000 cubic yards. (See Annual Reports, Chief of Engineers, 1881, p. 1653, and 1887, p. 3090.) quantity of sediment transported at any time varies with the velocity of the water. The velocity of the water flowing through the pool which the dam would create above it would be reduced at low water from about 2 feet per second (which at present exists in the river) to about three-tenths of a foot, and at bank-full stage from about 7 feet to 4 feet. As long as the current flows without interruption material in suspension moves down the river with the same velocity as the water, but a checking of the current will cause a deposit of immense amounts, deposits of from 20 to 60 feet in depth having been formed in a single season behind the permeable dikes constructed to improve the navigation of the river below St.

Louis.

While no complete investigations have been made to determine the fill above such dams, the results are of record at two important dams, one a high dam at Austin on the Colorado River of Texas, and the other a low dam for irrigation pur-

poses at Laguna, on the Colorado River of southwestern United States. Above the dam constructed at Austin, Tex., in 1893, there is reported by Prof. Thomas U. Taylor, of the University of Texas, a deposit in the first four years after its construction of 31,667,000 cubic yards, or 38 per cent. of its reservoir capacity. In a paper presented to the American Society of Civil Engineers, January 1, 1913, by Mr. H. T. Cory, a fill is reported above the dam at Laguna, Ariz., in one season of 20,000 acre-feet (over 32,000,000 cubic yards). Some idea of the extent of the fill to be expected on the Mississippi may be obtained from the sediment observations on the Missouri River near its mouth, taken at St. Charles in 1879. observations show that at a stage of about 20 feet above low water, with a mean velocity of 6.7 feet per second and a discharge of 257,000 second-feet 3,971,000 cubic yards of material were carried downstream in suspension per day. When the velocity was reduced to 3 feet per second, the amount carried in suspension per day was only 65,000 cubic yards, the volume of discharge at this velocity being 40,000 second-feet. ume of 257,000 second-feet at this reduced velocity would therefore carry about 416,000 cubic yards, and a deposit of 3,555,000 cubic yards per day is indicated for this stage as a result of the construction of the dam. The observations do not extend to the higher discharges, but assuming that at a bank-full stage in the Mississippi River below St. Louis with a discharge of 600,000 second-feet the amount per cubic foot carried in suspension did not exceed that at a 20-foot stage in the Missouri River, a reduction of velocities to 4 feet per second would cause a deposit of over 2,000,000 cubic yards per day for that stage. The pool above the dam would therefore rapidly fill, and unless dredging operations were undertaken on a scale never before attempted the bed of the river would rise, flood heights would increase, and the pool would soon cease to be of any value as a means of improving navigation.

As a means of overcoming these difficulties, it has been suggested that the regimen of the river above the dam be radically changed by increasing the depth and diminishing the width of the stream, so as to secure velocities equal to those which obtain under existing conditions. In a sewer or canal of regular section the corresponding problem admits of ready solution. In a river conditions vary from section to section, and the true mean depth can at best be only approximately determined. The mean velocity of the Mississippi River at this locality at low water is about 2 feet per second, which requires for exist-

ing slopes and widths a mean depth of about 6 feet. The slopes would be reduced by the construction of the dam to about one-half those at present existing, and to maintain the low-water velocity unchanged would require that the mean depth be increased to about 12 feet.

To insure a uniform velocity of flow in the proposed channel the tendency of the river to scour its bed and banks must be prevented, otherwise the pool and bar formation that now obtains in the river will be perpetuated. This renders necessary a complete regulation of the portion of the river affected.

It is, however, a mistake to assume that the excavation work could be left to be done gradually after first completing the dams. The erection of the dams would cause a radical change in the regimen of the river which, as shown above, would cause immense deposits unless a reduction of the velocities could be at the same time prevented. The channel excavation and regulation necessary for any adopted channel depth must therefore be carried on rapidly and, so far as possible, simultaneously with the creation of the pools. Every year's delay in the completion of the project would add enormously to its original cost, by reason of these deposits and their removal. 400,000,000 or more cubic yards of sediment flowing out of the Missouri River annually, the amount deposited would, therefore, depend on the rapidity with which the channel was built; but assuming that not more than 10 years were required to complete the channel and that the deposit were only 100,000,-000 cubic yards per year, the increase in cost from this item alone would be not less than \$100,000,000.

If abnormal accumulations of sediment, resulting from change of regimen due to the construction of the dam, must be removed as they occur, and if the regulation works must be prosecuted systematically and continuously so that the average depth shall increase as the average slope above the dam is diminished by its progressive construction, and builddredging problem of executing the ing the regulation works becomes one of extreme difficulty, since both operations, must be performed upon a scale not hitherto attempted. Considering the dredging alone, the dredged material must be completely removed from the limits of the regulated channel and deposited well beyond the reach of floods, to avoid interference with their free discharge. For handling even 100,000,000 cubic yards annually, the services of at least fifty 20-inch hydraulic dredges, working continuously throughout the year with double crews, would be required.

To construct and operate these dredges would in itself prove a formidable task. The regulation of the channel above the

dam would present additional difficulties.

The proposed St. Louis Dam furthermore involves the complete closure of a very large river, whose floods are exceeded in magnitude by few of the great rivers of the earth. prevent disaster to the work and to the occupants of the valley below, the dam, power house, and head bay walls must be built of masonry, founded on solid rock, at depths averaging about 77 feet below low water and 118 feet below extreme Variations of stage whose frequency and extent are illustrated by the accompanying hydrograph (see plate) and floods of as much as 1,300,000 cubic feet per second might occur during the construction work. Bridge piers have been built under such circumstances, but no dam has ever been attempted under conditions approximating these in severity. Keokuk Dam, which has just been completed, rock was everywhere found within 5 to 12 feet of the low-water surface, the extreme flood discharge for which provision had to be made was only about 325,000 cubic feet per second, with a height above low water of about 20 feet, and the site was otherwise naturally adapted to power-dam constructions, yet the work was difficult and expensive, requiring over two years to complete and costing about \$20,000,000. A detailed estimate of a project considered by the board to be preferable to that proposed by the Lakes-to-Gulf Deep Water Association is given in Appendix D. This estimate and a comparison of the difficulties of the Keokuk and St. Louis sites indicate that the St. Louis Dam, power house, and locks alone would cost over \$58,000,000. Dredging of deposits and regulation above and below the dam would add at least \$100,000,000.

It has already been noted that to permit the generation of power up to a bank-full stage it is necessary to lower the pool below the dam by the removal of a quantity of material estimated by the Lakes to Gulf Deep Waterway Association at 100,000,000 cubic yards, but computed by this board to be from 200,000,000 to over 750,000,000 cubic yards, dependent upon the channel depths to be obtained. Assuming the figure of 100,000,000 to be correct for the yardage of this special dredging and its cost to be \$25,000,000, and adding the cost of land damage and levee protection, amounting to over \$8,000,000, the total for the St. Louis dam would be over \$191,000,000. The greatest quantity of continuous power which the dam could generate would be that of low water, at which time, assuming the low-water discharge, including present authorized

diversions from Lake Michigan, as reaching a total of 40,000 second-feet, and the head as reaching 46 feet, the maximum output would not exceed 146,000 electrical horsepower, and the cost per horsepower would be over \$1,300, which far exceeds the cost at which water power can successfully compete with coal, even when the latter is much higher in price than it Moreover, although the now is in the vicinity of St. Louis. conditions are so unusual that it is impossible to submit a definite estimate of the cost of maintaining the proposed improvement, it is the opinion of the board that the mere cost of the dredging necessary to maintain the river channel in the unnatural condition contemplated by this project would far exceed the cost of the coal necessary for a steam plant capable of creating the same power as that of the dams.

The plan of the Lakes to the Gulf Deep Waterway Association for the dam near Commerce, which it is proposed should be similar to the St. Louis dam already discussed in detail, while not equally open to objection because of increase in flood heights, is nevertheless objectionable because of the failure of power at stages above bank-full stage and because of excessive cost, which latter, including cost of all requisite contingent works, would be about the same as that of the St. Louis dam.

As the dams proposed by the Lakes to the Gulf Deep Waterway Association would raise extreme floods 3 feet or more at St. Louis, as the power at both dams would fail above bank-full stage, as the cost of construction would far exceed the highest figure at which water power can successfully compete with steam power, and as the greater depths which the dam would create are not needed for navigation, this plan is without justi-

The board has, however, made studies of other plans, with a view to overcoming the objections above cited. these studies are fully described in Appendix D, in which it is shown that by suitable arrangement of the dams as to crest, elevation, and length, and by dredging, it may be possible to avoid the danger of increased flood heights at St. Louis, and of the failure of power at high stages at both dams, yet, under the most favorable circumstances, the final cost of dam construction, dredging, regulation, power installations, and other requisite contingent works would be more than \$428,000,000 for the two dams, while their continuous output would be not over 250,000 electrical horsepower, and therefore the final cost of development of power will be far too high to justify the undertaking.

The board accordingly reports that the improvement of the Mississippi River by high dams below St. Louis is without merit and unworthy of further consideration.

W. H. BIXBY. Brigadier General, U. S. Army, retired, President of the Board.

C. McD. Townsend, Colonel, Corps of Engineers, U. S. Army. C. KELLER,

Major, Corps of Engineers, U. S. Army. J. B. CAVANAUGH,

Major, Corps of Engineers, U. S. Army. JOHN BOGART,

Civil Engineer. [For report of the Board of Engineers for Rivers and Harbors, see page 3.1

APPENDIX A.

UNITED STATES ENGINEER OFFICE, Rock Island, Ill., August 13, 1913.

From: Maj. C. Keller, Corps of Engineers. To: The President, Lakes to Gulf Waterway Board.

Subject: Report on preservation of and compensation for

diminishing levels of Great Lakes, etc.

The following report upon "such measures as may be required to properly preserve the levels of the Great Lakes and to compensate, so far as practicable, for the diminished level in said Lakes and the connecting waters thereof by reason of any diversion of water from Lake Michigan for the maintenance of the proposed waterway

other purpose" is now submitted:

1. It seems hardly necessary to prove that if unaccompanied by works which will diminish the flow in the natural outlet, an artificial diversion caused by creating a new outlet for any body of water must lower its level below that which would have existed in the absence of the artificial outlet and diversion, and that the amount of such lowering will depend upon the size of the new outlet and the volume thus diverted. Certainly the asserted lowering would hardly be questioned were the diversion at Chicago of volume, for instance, equal to that of the natural discharge at Port Huron. examples in proof of this might readily be multiplied, but one will suffice: Consider the case of a trough or fountain basin

which receives a constant supply of water and from which the waste flows through a rectangular notch or cut in the rim, the maximum discharge capacity of the notch being slightly greater than the constant volume of water flowing into the As a result of the excess discharge capactrough or basin. ity of the notch, the basin will never fill flush to the rim, but will reach and maintain some level of equilibrium slightly below the top, and the waste will then equal the constant If now the size or cross section of the outlet is increased either by widening the first notch or by adding another one elsewhere in the rim, the volume of water outflowing will at once be increased and will then temporarily exceed the supply. The surface level of the basin will therefore fall until it is so low as once more to bring supply and waste into It is plain that the difference between the new equilibrium. level of the basin and its former elevation is due to the additional notch and is dependent on its size or cross section. same effects will follow even if the supply is variable, but it will of course be more difficult to demonstrate them directly.

2. On an enormously enlarged scale each of the Great Lakes reproduces these familiar conditions. The Lakes are large basins of water and formerly discharged through a single outlet. It is evident and has been definitely proven by gauge measurements that the volume discharged through any outlet varies with its size, increasing as the area of the outlet is increased when the level of the basin rises, and diminishing as the area of the outlet is reduced by a fall in the basin. The opening of the drainage canal at Chicago produced precisely the same effect on the Lakes as the second notch. creased the total area of the outlets, and if the water supply to Lake Michigan had been a fixed quantity, under constant atmospheric and barometric conditions, the lowering effect of this artificial outlet would have been definite and might after a suitable interval of time have been read directly from the gauges giving the elevation of the lake's surface.

3. But the amount of water supplied to each lake from its drainage basin and reaching its outlet varies from year to year with the quantity of rainfall (including snow), with the evaporation dependent upon the relative temperature of air and water and upon the prevalence or absence of wind, with the soil absorption dependent upon temperature, capillarity and dryness of the soil, and with other less important causes which affect the quantity of water and snow falling within the drainage basin, its return to the air direct or

through the soil and growing crops, and its delay by temporary storage within the soil. The surface levels of the Lakes vary correspondingly. In addition to the variations in the quantity of water supplied to each lake, complications are introduced by ice in the outlets, which may gorge and cause the lake above to maintain an abnormally high stage in calendar years with late springs and by wind and barometric effects, the latter two of which especially on Lake Erie sometimes cause large fluctuations in monthly surface levels. Plate 1 shows in separate curves the annual mean levels of all the Lakes, these levels being the integrated results of all the influences above described. A glance at these curves of annual levels will show their irregular rise and fall and the consequent difficulty of proving by direct evidence just what and how much is the effect upon lake levels produced by the creation of an artificial outlet, such as that at Chicago. It is further a well-known fact that the levels of all the Great Lakes are subject to considerable seasonal fluctuations, shown on plates 2, 3, 4, 5 and 6, which show certain curves of monthly mean lake levels. Generally speaking they are low in the early spring and late fall, and high during 3 to 4 of the spring and summer months. Such seasonal fluctuations are due to corresponding variations in the net supply of water to the various lakes, this net or available supply being in general low during the months of November, December, January, and February; high, due to precipitation and run-off during March and April; moderate in quantity during May and June; and thereafter again below the average. These differences in net supply are not immediately productive of corresponding changes in monthly levels which may and do lag as much as 3 or 4 months behind the acting causes. The extreme range of the monthly levels of the Great Lakes for the period 1860-1911, inclusive, has varied from 3.32 feet for Lake Superior to 5.54 feet for Lake Ontario, with maximum changes in a single period of 12 months of from 2.58 feet on Lakes Huron and Michigan to 3.97 feet on Lake Ontario. High water does not occur at precisely the same time on all the Lakes. to climatic causes, it is earlier for the lower lakes (Ontario and Erie) than for those above, the average difference in time between high water on Lake Ontario (May-June) and high water on Lake Superior (August-September) being nearly 3 months, and there is a corresponding interval between low waters (December-March on Ontario and February-April on Superior).

Thus while it is certain that the diversion of water through any artificial outlet cannot raise the lake levels and must either delay and diminish the raising or hasten and increase the lowering of the lakes involved, the proof of this conclusion must, because of the variations in the elevations of the lake surfaces just described, be indirect. Beginning in 1895, over five years before any diversion took place through the drainage canal, the United States lake survey, under the direction of the Chief of Engineers, United States Army, began a systematic series of measurements of discharge in the St. Marys, St. Clair, Detroit, Niagara and St. Lawrence Rivers to determine the relation, if any, which exists between the volumes discharged by those rivers and the levels of the lake surfaces. In order to determine the law connecting lake discharge and lake levels, the discharge observations have covered as wide a range of lake levels as possible. Up to the present the surface elevations during the measurements have for Lake Ontario (Ogdensburg gauge) varied between 242.9 feet and 246.3 feet above sea level; for Lake Erie (Buffalo gauge), between 570.0 and 573.92 feet; for Lake Huron (Fort Gratiot gauge), between 579.43 and 581.22 feet, and for Lake Superior (above Soo Locks), between The observations used for Lake Supe-601.30 and 602.30 feet. rior are those of September, 1909, at Sault Ste. Marie, which are the latest taken at this locality.

5. These discharge measurements have been numerous and the range of lake-surface heights has been sufficient to demonstrate conclusively that there is a direct connection between the height of each lake and the volume of water discharged at its outlet. The observations have been carefully made, so that it is possible to state with some precision how much the discharge of any one of the lakes is increased by a given rise in its surface or, conversely, how much the discharge will decrease for a corresponding fall. For a change of 1 foot from the mean of the stages covered by the observations on each lake the discharge will change as stated in Table 1.

TABLE I.

Lake.	Mean stage,1	Discharge at mean stage.	Change in discharge due to 1 foot change in level close to mean stage.					
Superior	601.80	75,000	15,300 gauge at S. W. canal pier. 21,500 Fort Gratiot gauge. Lake St. Clair normal. 22,300 Buffalo L. H. gauge. 23,300 Ogdessburg gauge. Discharge adjusted for effect of closure of Gut Chaasel in Galops Rapids, estimated to reduce existing discharges 9,000 cubic feet per second below those formerly existing at the same stags.					
Michigan-Huron	580.38	192,300						
Erio	571.94	195,500						
Outario	244.60	330,000						

¹Mean of range during discharge measurements.

A change in level of 1 foot at high stages is accompanied by a somewhat greater change in discharge than at lower stages, because at the higher stages a given change in level has a greater effect upon the area of the outlet, but only the mean values given in the above table are used in this dis-Thus it would appear that for each level of any of the lakes there is a corresponding discharge fixed and determined by that level, and that on the other hand when the discharge is given the level of the corresponding lake is also fixed. With a definite change of surface height there is a corresponding increase or decrease of flow, as shown in the preceding table. The fact that an artificial increase in outflow, such as that due to the diversion at Chicago, will lower the lake immediately concerned and all dependent on it for their supply, is a direct and necessary inference from the above discharge measurements. Any such increase of discharge above that which is the natural result of an existing lake level will have the effect of drawing upon the stored water available in the lake at a greater rate than before. the lake will fall more rapidly and further than it would have done due to the natural discharge at the natural outlet, and the level to which the lake will finally fall is that at which the discharge through the natural or main outlet equals the normal discharge less the diversion. The total drop in the level of the lake surface, due to the diversion, is then plainly that which is necessary to make the total outlet area (the sum of the areas of the natural and artificial outlets) correspond to the total available supply. Conversely, a reduction in outlet area causing a diminution in outflow will result in raising the level until the discharge area once more corresponds with the available supply. This is actually taking place on Lake Ontario, where the closure of the Gut Channel of the Galops Rapids has apparently caused a rise in the surface of Lake Ontario of 0.39 foot or more. Based upon the quantities given in Table 1, the changes of level, in feet, due to direct diversions of amounts varying between 1,000 and 14,000 cubic feet per second, are shown in Table 2.

TABLE 1

1,000 cubic feet.	Superior.	Michigan and Huron.	Erie.	Ontario.		
1 2 3 4 8 6 7 8 9 10 11 12 13 14	Foot. 0.065 131 196 201 327 392 447 633 563 664 719 784 880 915	Foot. 0.048 .095 .139 .186 .232 .279 .325 .373 .419 .465 .558 .602 .689	Foot. 0.045 090 134 170 234 239 314 359 404 448 493 583 583 623	Foot. 0.043 .088 .129 1.72 .2165 .200 .303 .346 .399 .431 .474 .517 .560 .603		

6. With the outlets free of ice at any instant the volume of water discharged from one of the lakes is a definite quantity fixed by the level of the lake. With a constant supply of water and constant evaporation there would then be no change in the elevation of the lake's surface, except such temporary changes as might be caused by winds and barometric disturbances. But the flow into each lake is, as has been explained, constantly varying, and while the discharge from the lakes is also ever changing, so as in the long run to tend to counterbalance changes in supply, yet these adjustments of supply and discharge are not simultaneous, and the surface levels of the lakes are therefore constantly fluctuating, as is readily seen from the plates attached.

7. These regular but uncontrollable changes in lake level mask the effect produced by an artificial diversion. Such diversion plainly is an increase of the natural discharge and therefore disturbs the general equilibrium between supply and discharge which in the long run exists. If at the time of this diversion the lakes are rising, it will reduce the rise; if they are falling, it will increase the fall; and the net effect of the diversion will unquestionably be a reduction of the level which would have existed. This diminution of level is simply that corresponding to the finally lessened outflow at the natural outlet, and its amount can be determined from Table 2.

8. The above diminution of level caused by a diversion of given volume will not be immediate. A considerable time

will elapse before any large part of the ultimate lowering of any of the lakes will have taken place. The time required to produce the lowering due to an artificial diversion from any of the lakes will depend on its surface area, so that the smaller the lake the sooner a diversion of given volume will produce its corresponding effect. As shown in the report of the Lake Survey for 1904, page 4120, half of the ultimate fall of Lakes Michigan-Huron will occur in 1.46 years, and nine-tenths of the fall will be completed in 4.86 years, so that the effect of a diversion is slow to appear, and, as stated, changes in precipitation and run-off may serve to obscure the effect. For each lake of the Great Lakes system the time required for 50 per cent. and for 90 per cent. of the ultimate lowering is shown in Table 3.

TABLE 3.

Lake.	Time required to produce 80 per cent of ultimate lowering.	Time required to produce 90 per cent of ultimate lowering.		
Suyerior Michigan-Huron St. Clair Erie. Ontario.	14.4 months 18 months 46 hours, or 0.906 month. 2.5 months	47 months. 58 months. 6.4 days, or 0.213 month. 8 months. 7 months.		

9. The lowering due to an artificial diversion is not, moreover, confined to the single lake from which the diversion proceeds, but like effects may be caused in the lakes and connecting channels above and below. The diversion at Chicago, now under consideration, is widespread in its hurtful effects, Lake Superior, by reason of the fall of 20 feet between it and Michigan and Huron, being the only one not injured thereby, though it should be noted that injury is unquestionably done at all of the channel of the St. Marys River in the 49½ miles from the upper sills of the locks at Sault Ste. Marie down to Lake Huron.

10. From plates 1 to 6, herewith, it will be seen that the annual level of Lake Superior has been falling since 1905, during the six years between 1905 and 1911 having dropped about 1.3 feet, corresponding to a loss of storage capacity of more than six months' total discharge. Lakes Michigan, Huron, and Erie have been falling since 1908. In the three years between 1908 and 1911 they have each dropped more than 1.13 feet, and Lake Ontario has dropped about 2.2 feet in the same time. On all the four lower lakes the mean water surface for 1911 was at least 1.2 feet below the mean level of the past 52 years. Lakes Michigan and Huron were in March,

1911, at elevation 579.30, only 0.30 foot above their lowest recorded monthly stage since 1860, and the lowest monthly stage in 1911 on Lake Erie, 571.04, was only 0.35 foot above the lowest recorded monthly mean for that lake. These low stages are accompanied by corresponding reductions in the depths of the St. Marys, St. Clair, and Detroit Rivers, and the harbors upon Lake Erie, and as the depths of these harbors and connecting channels limit the draft to which vessels may load, the result is a corresponding loss of productive capacity in the large lake fleet, which is now designed and built to take advantage of every inch of depth available at these critical points. The largest lake freighters when nearly fully loaded carry over 80 tons of freight for each addition inch of draft. A diversion of 10,000 cubic feet per second from Lakes Michigan and Huron by the Chicago Drainage Canal will, as shown above, eventually reduce the average level of those lakes at least 0.465 foot, or 5.58 inches, and of Lake Erie 0.448 foot, or 5.38 inches, the losses of depth along the St. Clair and Detroit Rivers being intermediate between these values. Consequently, in addition to the unavoidable losses caused by the reduction of lake levels due to natural causes, an uncompensated Chicago diversion of 10,000 second-feet for each single down trip of such a vessel would cause a loss of about 446 tons of carrying capacity. An average of 25 trips per season would mean a loss of at least 11,150 tons, which at 55 cents per ton would during a busy season represent an annual loss of over \$6,000 for the down trips of each large vessel. Each season many vessels of such size as to be affected by any loss of depth caused by a Chicago diversion pass through the locks Based upon the known characteristics at Sault Ste. Marie. and numbers of the lake fleet, it has been estimated that the total annual loss due to a Chicago diversion of 10,000 secondfeet might be over \$1,000,000, and this would increase with number and size of vessels. A diversion of 10,000 secondfeet at Chicago has not been authorized, but the diversion already made has produced a proportionate loss in depth and revenue. To prevent this loss, remedial measures are necessary.

11. The Board of Engineers on "Deep Waterways between the Great Lakes and the Atlantic Tidewaters" in its report of June 30, 1900, House Document No. 149, Fifty-sixth Congress, second session, pages 273 to 293, presented a plan for the regulation of Lake Erie between fixed levels by the construction of submerged weirs aggregating 2,900 feet in length, combined with 13 adjustable sluices, each 80 feet wide, controlled by Stoney gates, these works to be built at the foot of Lake Erie, just below Buffalo Harbor. The regulated level proposed was 574.7 feet above sea level, about a half foot below extreme high water in Lake Erie, and it was stated that these works would hold the lakes within 0.6 foot of the adopted level, temporary violent fluctuations not considered. It was further stated that the result of such regulation would be to raise the lake surface about 3 feet above its ordinary low-water elevation. Moreover, while the low-water level of Lake Erie would be raised about 3 feet, it was estimated that by backwater Lake St. Clair would be raised about 2 feet

and Lakes Michigan-Huron about 1 foot.

12. In House Document No. 779, Sixty-first Congress, second session, pages 10, 11, and 12, and pages 49 et seq., it is clearly shown to be impossible to regulate Lake Erie within the limits proposed in House Document No. 149, owing primarily to its wide and lawless variation in supply and further to the lake's sudden and violent oscillations, which have amounted to as much as 2 feet in an hour and 8 feet in a day, the difference in levels between the two ends of the lake in extreme cases having at times been as much as 15 feet. The views expressed in House Document No. 779 are summarized as follows: The regulating works, situated as proposed, would tend to aggravate ice jams at the head of the Niagara, which in turn might, during southwesterly storms, cause disastrous inundation of the lower lying parts of Buffalo. Moreover, the ice gorges now occurring at the Horseshoe Reef at the head of the Niagara River retard the opening of the season of navigation at Buffalo, and an aggravation of these gorges might serve to increase this delay, while the works themselves might under these conditions be difficult to maintain, and furthermore, even during the ice-free months, raising the level of Lake Erie by 3 feet would increase the overflow damage caused at Buffalo by severe southwesterly Floods from Buffalo Creek would also be more damaging, while low-lying lands along the entire extent of the shore line of Lake Erie would be permanently submerged. Such regulation, accompanied as it would be by a change in the outflow of Lake Erie, would prove detrimental to depths in Lake Ontario and in the St. Lawrence River. Regulation of the level of Lake Erie between wider limits, even between 572 and 574.5, does not, in view of its disadvantages, appear to be desirable. Regulation of the level of Lakes Michigan and Huron would, if feasible, prove beneficial only on those lakes and in the lower St. Marys River, and would be detrimental to

the lakes and rivers below. Due to the extremely wide variations in supply, however, the regulation of Lakes Michigan and Huron is not considered feasible. Moreover, the works necessary for regulation would probably cause a serious obstruction to navigation at the head of the St. Clair River.

In the Transactions of the American Society of Civil Engineers, vol. 63, June, 1909, Mr. C. E. Grunsky, member American Society of Civil Engineers, proposes the use of Lake Superior as a storage reservoir, regulating it at a high stage within the narrow limits with a view to delivering a large flow at low stages of Lakes Michigan and Huron, thereby neutralizing in part at least the harmful effect of the Chicago diversion. Concerning this it may be said that the level of Lakes Michigan and Huron depends on the total quantity of water supplied to them and the area of their outlet, and that, unless one or both of these are altered, it is impossible to cause any change in their mean level over a series of years. Since storage in Lake Superior cannot increase the total supply to Lakes Michigan and Huron, its only effect will be to lower the latter lakes and those below while accumulation of water is going on in Lake Supe-When the stored water is subsequently discharged at perhaps an abnormally high rate of flow, the surface of the lakes below may, for a relatively brief period, be elevated above its natural height more than it had previously been depressed, but the duration of such increase will be correspondingly brief, and in the long run, the mean stage of the lakes will not be benefited. Storage in Lake Superior may also, at the expense of an increase in its fluctuations, reduce the range of fluctuation of Lakes Michigan and Huron. Such a change will not compensate for the absolute loss of water caused by the Chicago diversion, and will not benefit Vessels habitually load to the extreme draft permitted by the minimum depth along their route, and reduction of the range of annual fluctuation of Lakes Michigan and Huron will, during the season of navigation, afford no greater average depth in the lakes and channels below the locks at Sault Ste. Marie, while the increased fluctuation of depth in the St. Marys River and in Lake Superior may prove exceedingly damaging.

14. In House Document No. 779, Sixty-first Congress, second session, pages 56, 57 et seq., is a further discussion showing the impracticability of regulating Lake Superior between fixed limits and of using it as a storage reservoir to

compensate for the loss of levels on the lower lakes due to the diversion at Chicago. Moreover, the mean level of Lake Superior for 1911 was 0.84 foot below its average of the 52 years, 1860-1911, and its outflow should now be restricted rather than increased, although the need for water below was never greater.

15. Mr. F. C. Shenehon, member American Society of Civil Engineers, has presented for the consideration of the board two plans, one for compensating, the other for regulating the levels of Lake Erie, each of them involving the con-

struction of certain works in the Niagara River.

The first plan, as set forth in his letter of October 12. 1912, with plates 8 and 9 attached hereto, proposes the construction immediately above the Falls of a submerged dam or weir across the Niagara River from Port Day to a point This weir would, it is opposite it on the Canadian shore. asserted, raise the Chippewa-Grass Island Pool about 6 inches, and, through back-water effects, raise Lake Erie about 1 inch, with proportionate effects at intermediate points. In another place it has been estimated that a diversion of 20,000 secondfeet from the Chippewa-Grass Island Pool will lower Lake Erie about 1 inch. The existing diversion on the American side of the pool is 15,100 second-feet, so that the proposed weir would compensate the level of Lake Erie for somewhat more than the lowering estimated to result from the diversions of the American power companies at Niagara Falls. At the same time the weir, located as proposed, might considerably improve conditions of flow at both ends of the Horseshoe Falls. This plan, while probably of benefit in connection with power and scenic conditions at Niagara Falls, does not, however, fully compensate for "diversion of waters from Lake Michigan," and while it may have merit, the board does not deem it necessary to discuss it further.

17. The second plan of Mr. Shenehon is for intermittent regulation of the level of Lake Erie by constructing, 1,000 feet below the Buffalo waterworks intake pier and just above the International Bridge, an adjustable weir about 480 feet in clear width, which, when completely closed, will diminish the outflow of Lake Erie by about 30,000 second-feet. Were the gates constantly closed, this would result in raising the level of the lake somewhat less than 1.5 feet, but it is proposed to operate this weir so that the flow shall be intermittent and to hold the level of Lake Erie during the navigation season a

little higher than elevation 573.

18. Largely in the interest of the power companies and of scenic conditions at Niagara Falls, Mr. Shenehon proposes to keep the gates continuously closed during November and December and to remove them entirely during January, February, March, and April. During the months May to October, inclusive—that is, during the season of navigation and of pleasant weather when visitors at Niagara Falls are most numerous—the gates are to be operated so as to reduce the flow of the Niagara River to about 190,000 second-feet during evening, night, and early morning hours-16 hours in all, and to increase the flow to 220,000 second-feet during eight Such an arrangement would, it is urged, daylight hours. improve scenic conditions at Niagara Falls and would further help the power companies better to carry their peak loads without diminishing the daily flow over the Falls below

its former natural volume.

19. The mean level of Lake Erie for the 52 years, 1860-1911, inclusive, is 572.56. Were it possible to hold its mean level at 573 during the months of navigation, the level of this lake would be raised about half a foot above its annual mean, and this would compensate Lake Erie for the lowering due to a diversion from Lake Michigan of over 11,000 second-feet and by back-water effects would, it is believed, compensate Lakes Michigan and Huron for a diversion at Chicago of about 3.250 second-feet. The benefits of this plan of regulation would be greatest whenever the lake fell below its mean level, 572.56, and, at lower natural stages of Lake Erie, such regulation might result in compensation on Lakes Michigan and Huron for a Chicago diversion of perhaps 6,000 second-Mr. Shenehon's proposal differs in detail, but not in principle, from that proposed by the Board of Engineers on "Deep waterways between the Great Lakes and the Atlantic tidewaters," in House Document No. 149, Fifty-sixth Congress, second session, which is discussed in paragraphs 11 and 12 of this appendix. The objections to this plan are those which apply to any scheme for regulating the lakes-i. e., to substituting controlled and artificial levels and fluctuations It is not believed that of levels for those which now exist. any scheme of regulation has sufficient advantage over the plan of compensation by means of contraction works in the outlets to justify its adoption. The contraction works permit the natural oscillations to continue undisturbed and cause no vital change in stages and in oscillations of the lakes below. Moreover, under Mr. Shenehon's plan the extent of compensation on Lakes Erie and Michigan-Huron will vary with natural conditions, compensation on Lakes Michigan and

Huron at times being sufficient for a Chicago diversion of perhaps 6,000 second-feet; at other times for a diversion of perhaps less than 3,000 second-feet, with similar variations For full compensation on Lakes Michigan on Lake Erie. and Huron, for diversion greater than about 6,000 secondfeet, supplementary works in the St. Clair River would probably be necessary. Contraction works on the other hand, operate automatically and fully compensate for the actual di-Further objections to this plan of regulation are the deleterious effect upon Lake Ontario and the St. Lawrence River, due to prolonged storage in Lake Erie, and there is also a possibility that a succession of years of low precipitation might render the plan wholly inoperative. Shenehon's letter of October 29, 1912, with plate 10 attached, appended hereto, fully explains this plan of intermittent regulation.

As shown by the great uniformity of flow in their connecting rivers when compared with other streams of corresponding magnitude, the Lakes themselves in their natural state regulate the flow in these rivers automatically and far more perfectly than can be done by human agency. ficial regulation is impracticable because of the utter impossibility of predicting precipitation, run-off, and evaporation for one or more years in advance of needs. Moreover, it is in the connecting rivers that the limiting depths available for navigation have usually been found, and there the depth might be affected unfavorably by any plan involving storage. To prevent dangerous interference with this beneficial natural adjustment of the flow, compensation must be attempted only so far as will not interfere with natural oscillations.

21. The diversion at Chicago transfers from the drainage basin of the Lakes to that of the Illinois River a considerable portion of the water supply which naturally belongs to the Great Lakes and lowers the level of the entire system from and including the lower sills of the locks in the St. Marys River down to the mouth of the St. Lawrence. once diverted at Chicago is forever lost to the St. Lawrence Basin. To restore the natural depths of the channel in the lower St. Lawrence River is impossible except by dredging, and in the upper St. Lawrence only by more or less extensive

and expensive works.

The loss of depth on Lake Ontario, due to a diversion of 10,000 second-feet, would be 0.431 foot, or 5.2 inches. The closure of the Gut Channel of the Galops Rapids by the Canadian Government in 1903 has had the effect of raising the

level of Lake Ontario by about the same amount. No further compensation is therefore at present necessary on Lake Ontario to restore its natural levels. The head of Galops Rapids will probably afford an advantageous site for a submerged dam or weir to obstruct further the area of the channel through which Lake Ontario discharges, and no great engineering difficulty should be experienced in securing any reasonable increase of level on this lake, but storage in this lake would, temporarily at least, diminish depths in the St. Lawrence River. On plate 7 is shown an extract from the Lake Survey chart of the locality, where additional compensation works may most readily be built when desired.

23. For the channels and lakes from the foot of Lake Erie to the St. Marys Locks, so far as affected by the Chicago diversion, a plan of compensation seems feasible which will not

disturb natural conditions.

To compensate for the reduction of level in Lake Erie, the outflow capacity of the Niagara River must be diminished. By building submerged weirs or contraction works a short distance below its head, this may be done without altering the range and the periods of the natural oscillations of the At the same time, the free flow down the Niagara River will remain practically unchanged. A proper location of the weirs, which will be of moderate height, or of the contracting dikes will not increase the danger of ice gorges in the upper Niagara River. A diversion of 10,000 cubic feet per second at Chicago would lower Lake Erie 0.45 foot. Weirs and contraction works may safely be built in the portion of the Niagara River at the foot of Squaw Island, near Austin Street, shown on plate 7, and computation shows that to produce a rise of 0.45 foot on Lake Erie, the rise at Squaw Island must be 0.85 foot. Three weirs, one at the foot of Squaw Island, the others half a mile above and below, respectively, and averaging 4.2 feet in height above the present river bed will produce the desired rise of 0.85 foot at Squaw Island and will thereby compensate for the diminished levels of Lake With a top width of 6 feet and side slopes of 3 horizontal to 1 vertical, these three weirs would contain about 15,000 cubic yards of material and, if built of solid masonry, at \$10 per yard would cost \$150,000. In place of these submerged weirs contraction works at the same locality would produce the same result at somewhat higher cost, but to avoid undesirably great effects at higher stages these contraction works should not extend above mean stage.

It is known that when the surface of Lake Erie is elevated there will be some backwater effect on Lakes Michigan and Huron, estimated to be slightly more than one-third the rise of Lake Erie. Assuming the surface of Lake Erie raised 0.45 foot, it is estimated that the backwater rise of Lakes Michigan and Huron may be as much as 0.16 foot. diversion of 10,000 second-feet at Chicago would lower Lakes Michigan and Huron 0.47 foot, and the difference between this and the above backwater effect, or 0.31 foot, represents the additional amount which the surface of Lakes Michigan and Huron must be raised to compensate for such diversion. The St. Clair River is a main artery of the highly important lake traffic, and if submerged weirs are to be built in this river to raise the level of Lakes Michigan and Huron, sites must be chosen and the weirs built to such height that the depth over them will be ample and that navigation may remain convenient and unobstructed. The average depth of the St. Clair River for a considerable distance below the mouth of Black River at Port Huron is 30 feet, and six weirs may be built below that point, at distances averaging half a mile apart, which will raise the surface of Lakes Michigan and Huron the desired amount and will not reduce the depth over the weirs and elsewhere below 24 to 25 feet. The mean velocity of the current in this vicinity would be increased from about 3.28 feet to about 3.89 feet per second, or to about 24 miles per hour, and the effect of this increase would be felt over a distance of about 3 miles below the upper weir, while above it the river slopes and velocities, now excessive, will be diminished and navigation will be benefited. The weirs, located as above, should have a height of about 5 to 6 feet above the river bed, and six weirs would require about 65,000 cubic yards of stone, which, at \$5 per cubic yard, will cost about \$325,000. Contraction works in the same locality will, at higher cost, produce the same result, but they must, as previously noted, be restricted in height to mean stage.

26. The Chicago diversion, nor any from the lower lakes,

will have no effect upon Lake Superior.

27. The plan of compensation herein proposed has the advantage of simplicity and relative economy. Moreover, the submerged weirs may be systematically and progressively built, so as to permit close observation of their effect and such changes in plan as experience gained during construction may suggest. On the other hand, the Niagara River weirs, so long as they exist, would certainly interfere with the navigation of the main channel of the Niagara River and at some

future time might thereby interfere with the deepening of the channel. Present navigation would, however, be sufficiently served by the new lock at Black Rock. A further minor criticism of the proposed Niagara River weirs is that they do not, as would a high weir close to Niagara Falls, prevent the power diversions at Niagara from slightly lowering the level of Lake Erie; but the weirs are designed to compensate for the effects of diversions from Lake Michigan only. The consideration of compensation for the effects of diversions from the Niagara River is not included in the board's duties, but such compensation could readily be pro-

vided by slight modification of the weirs proposed.

28. Compensation for the loss of elevation on Lakes Michigan, Huron and Erie and connecting waters, due to an assumed diversion from Lake Michigan of 10,000 second-feet will, by the plan above outlined, involve a total expenditure of at least \$475,000, to which must be added a small amount, possibly \$15,000 annually, for the maintenance of the remedial works. This volume of 10,000 cubic feet per second has been assumed merely as a basis for computation. The cost of compensation for a diversion of different volume may be determined in the same manner. The cost of these compensation works is only part of the price that must be paid because of any diversion from Lake Michigan, and it is believed that this at least should be paid by the direct beneficiary of the diversion.

C. Keller, Major, Corps of Engineers.

LETTER OF MR. FRANCIS C. SHENEHON.

Minneapolis, October 12, 1912.

Board of Engineers on Lakes to Gulf Waterway.

Sirs: 1. On behalf of the Hydraulic Power Co. of Niagara Falls, I have placed in your hands two blue-prints, showing in plan and in section a proposed submerged rock weir in the Niagara River above the Cataract Rapids. This weir will reach from Port Day to the Canadian shore.

2. These blueprints are submitted, and this statement of the object of the weir, because I understand that the compensation of the water diverted by the Chicago

Drainage Canal or by the Lakes to Gulf Waterway is a

part of the matter to be included in your report.

3. It is well known to you that at the present time 15,100 cubic feet per second of water is diverted from the Niagara River above the crest of the rapids by the two large American companies. It is further known that the treaty with Great Britain permits a diversion ultimately of 20,000 cubic feet. It has been reported that the diversions of the above amounts in the Niagara River cause some small lowering of the river in this vicinity. The object of this weir is to raise the water level in the Grass Island Chippewa Pool to the betterment of navigation, and in compensation of the computed lowerings from diversions in the Niagara River itself and at Chicago.

4. The weir is built of bastard limestone in large blocks and will have a crest width of about 100 feet. As designed it will require about 42,000 yards of rock and its crest level will be about 6 feet below mean water level

5. The rise in the river due to this compensating weir will be approximately as follows:

Lake Erie	Voluma	Rise caused				
level.	River.	Diversion.	Over weir.	by weir.		
Feet. 571.36 572.26 573.36 874.26	180,500 202,500 224,500 246,800	19,500 19,500 19,500 19,500	161,000 183,000 205,000 227,000	Feet. 0.02 .58 .85 .82		

The greater rise for low water is beneficial to navigation.

6. As to the method of computing the effect, it should be stated that engineering literature does not contain any great help in a problem of this kind, except as it teaches certain fundamental hydraulic principles which govern flowing water. The river section on the line of the proposed weir has an area of 38,400 square feet, when Grass Island-Chippewa Pool is at elevation 562.32, and the discharge of Lake Erie for its corresponding elevation is 224,500 cubic feet per second. Of this 19,500 cubic feet is taken as diverted above the weir. This leaves the flow over the weir 205,000 cubic feet per second, with a mean velocity of 5.34 feet per second. When the section of the river is reduced to 27,200 square feet of area by

the rock weir, the mean velocity must be 7.54 to pass the flow. In order to speed the water up to this velocity, a head of 0.43 foot with 100 per cent. efficiency is required. As some wasted effort enters, the efficiency of the velocity head is taken at 80 per cent., and the river rise must then be 0.54 foot, or, in view of some uncertainties, 6 inches roundly.

7. This operation may be expressed by the following

equation:

$$R = \frac{\left(\frac{Q'}{a}\right)^2 - \left(\frac{Q'}{A}\right)^2}{2\alpha k}$$

In this equation-

R is the river rise created, in feet.

Q' is the discharge over the weir, in cubic feet per second.

A is the natural cross-sectional area of the river, in square feet.

a is the river section, with the weir constructed, in square feet.

g is the acceleration of gravitation, 32.2. k is a coefficient of flow, taken here as 0.80.

8. It should be stated that it is not necessary to build any more of this compensating weir than will give the desired change or rise in the water level. As the construction progresses water gauges at Buffalo, at Chippewa, at Suspension Bridge, and in the Whirlpool will measure accurately the effect produced. When enough rise is secured, the construction may be stopped. Should the weir as designed be insufficient, some small addition will bring the rise to the proper amount. For this reason the proposition does not rest on any involved mathematical deductions.

9. It should be stated that the rise in river elevations due to this submerged rock weir will have its maximum value of about 6 inches just above its crest, and that the rise in Lake Erie will be about 1 inch. Between these two points the rise in river level will vary somewhat as

the distance upstream above the weir.

10. This submerged rock weir is suggested to the Board of Engineers as an engineering proposition which will be beneficial to the navigation of the river and as tenoing to compensate more than twice the effect which could possibly be attributable to the diversions present

or anticipated of this particular company. It is known to the board that the authorized diversion of this company is 6,500 cubic feet per second, and that the actual diversion is slightly less than this. The original recommendation of the American section of the International Waterways Commission for the quantity of water to be apportioned to this company was 9,500 cubic feet per second, and was based on the commission's interpretation of the charter rights of this company from the State of New York. Their canal has a capacity for this flow. Should the Government issue a permit to the Hydraulic Power Co. to divert this additional 3,000 cubic feet per second, it might attach as a condition thereto that the company should contribute toward the expense of the proposed submerged weir. It is understood that the jurisdiction of this board does not touch the question of additional diversions to be authorized. It does seem proper, however, to state the condition under which the company might be called upon to contribute to a construction which will compensate for the lower river, not alone their desired diversion, 9,500, but will compensate in addition, in the immediate vicinity of Port Day, a diversion of 10,000 cubic feet per second at Chicago.

Respectfully submitted.

FRANCIS C. SHENEHON.

LETTER OF MR. FRANCIS C. SHENEHON.

Minneapolis, October 29, 1912.

To the Board of Engineers on Lakes-to-Gulf Waterway.
Sibs: 1. In addressing you upon the subject of the regulation of Lake Erie, I wish to express my feeling of personal humiliation that, after so many years of investigation of all the hydraulic elements involved in making Lake Erie, the Detroit River, and Lake St. Clair better navigable ways, nothing has been accomplished up to the present time in regulation. The low water on the Great Lakes of 1895-96 demonstrated the fatuity of letting unrestricted natural conditions produce random results. This was economically most harmful to the carrying trade of the great Lakes.

2. As a result of the low water of 1895-96, the Angell-Cooley-Russell Commission recommended the appoint-

ment of a board of engineers to investigate the subject of regulation, in connection with the larger subject of water-

ways to the sea.

3. In the report of the resulting board, consisting of Col. Raymond, Alfred Noble, and George Y. Wisner, the regulation of Lake Erie was specifically recommended. The distinguished personnel of this board gives great weight to its recommendation. In some respects, however, the scheme of the board was criticised. An attempt was made in the scheme of regulation to maintain Lake Erie at a level probably too high for all the conditions involved. The regulating works were to be placed above the head of the river, and with piers spaced so close together that the retardation of the ice fields was likely to be brought about. In addition the expense of building the regulating works was very considerable. The report of this board was made in 1898.

4. The present International Waterways Commission, so far as may be learned from its report of 1910, is not likely to make any recommendations for the regulation of Lake Erie, but will report in favor of compensating works instead. It is understood that the functions of this commission so far as international boundary streams are concerned has now been taken over by the commission created by the treaty of 1910 with Great Britain. Unless your honorable board should find the regulation of Lake Erie a proper subject for report, this important matter is likely to be relegated to a commission not of en-

gineers.

5. My own investigations and studies of the hydraulics of the Niagara River, begun in 1898, have convinced me that a considerable betterment of the level of Lake Erie, of the Detroit River, and Lake St. Clair is entirely feasible at a reasonable expenditure for controlling works and at a small cost for maintenance. It was estimated by the Angell-Cooley-Wisner Commission that a foot in depth on Lake Erie harbors would save in dredging operations \$1,000,000. This estimate, I understand, does not take into consideration the shallow west end of Lake Erie, including the approach to the Detroit River, the Detroit River itself, and Lake St. Clair.

6. The question of the regulation of Lake Erie has grown additionally important by reason of the entrance of two elements other than navigation. These are the

desirability of maintaining scenically effective the cataract at Niagara Falls, while the average flow over the cataract is diminished by such considerable quantities of water as are authorized by the treaty of Great Britain, and the need of making the diverted water, under the treaty with Great Britain, as efficient as possible as a power resource of the people of two nations. While navigation may still be regarded as predominant, the economic value of water power in the Niagara River and the æsthetic value of a spectacle internationally in trust must receive the highest consideration.

7. In presenting to you a scheme for the regulation of Lake Erie it is believed that the method used will be helpful to the three things involved—navigation, water

power, and scenic grandeur.

8. It may be claimed for the method of regulation used that while it does not aim to hold Lake Erie within narrow limits, it will better the low-water level of the lake by at least a foot, and that no danger will arise from the

method used of excessive high water.

It is a well-known fact that ice in the St. Lawrence River so retards the river flow that Lake Ontario is on an average about 7 inches higher than it would be in the absence of the winter season. It is well known also that the flow of the St. Clair River is at times much reduced by ice conditions. It has been estimated that the value of the ice period on the levels of Lakes Michigan and Huron is perhaps 6 inches. The peculiar beauty of the ice regulation is that during the season of navigation not a vestige of the ice-regulating works remains. They have completely disappeared and have left the channels in their full outflow sections. The peculiar disadvantage of the ice dam lies in the fact that this formation bears no relation whatever to need, but is a function of the coldness of winter. The coldest winter may come at a time when the lake has no need of any further lift. In the Niagara River the effect of ice is practically negligible so far as the level of Lake Erie is concerned.

10. The regulating works recommended by me take the one from nature and the ice dam by providing a form of dam which practically retains, when the gates are lifted, the original outflow section of a river. This insures the

avoidance of unduly hugh lake stages.

11. It is proposed to place three piers on the solid limestone bottom of the upper Niagara River, perhaps a thousand feet below the Buffalo Water Works' intake pier. These three piers, with gates to work from truss work built upon these piers, intercept, when the gates are lowered, about 500 feet of the river flow. The piers are spaced so as to have a clear waterway of 240 feet. With this clear waterway between piers no danger of ice blockades will be present. This is a known fact because the International Bridge crossing the river a little further below has clear openings of from 187 feet to 235.8 feet. The clear openings for the regulating works proposed by me are greater than any opening of the International Bridge. The plan proposed is shown in sheet 1 appended to this report.

12. The regulating works are designed to lessen the river flow at any time by about 30,000 cubic feet per second. Should the gates remain permanently closed, this would result in raising Lake Erie a little less than a foot and a half. It is purposed, however, to operate the gates so that the flow is intermittent. That is, the gates during the open season will perhaps be wide open during certain of the daylight hours and closed during the night hours. The effect of this will be to create night conservation for larger daylight flow. The resulting effect on Lake Erie will, as before stated, be perhaps a betterment in level of 1 foot. It should be stated, however, that the betterment of level would consist in the avoidance of levels below 573 rather than in any attempt to keep the

lake at high lake levels.

13. The conditions leading to the intermitten regulation of the flow of the Niagara River are developed from the following conditions of the three uses of the water of Lake Erie and the Niagara River. Only one use, that for power, needs to go on continuously 24 hours a day, and every day in the year. Navigation has a duration of 8 months out of 12. Scenic grandeur, so far as it depends on great volume of flow, may be limited to the six months, May to October, inclusive, and to the daylight hours of those months. As pointed out in my report on the preservation of Niagara Falls (S. Doc. No. 105, 62d Cong., 1st sess.) during the winter months volume of flow is subordinated, because ice and frost effects add new scenic beauty, and because visitors are few; perhaps a tenth of all visitors coming in the months November to April.

14. Notwithstanding the closing in of the night or the absence of seeing eyes, the splendid barbaric, prodigality of nature maintains the seaward rush of the waters. Just a lttle lessening comes in the midwinter months, when ice affects a slight restraint. During the night hours a chance is presented to lessen the prodigal waste and to store up water to maintain in the daylight spectacle

much of its natural grandeur.

15. Taking 200,000 cubic second-feet as the mean river flow, after deducting all up-lake diversions, and 572.2 as the corresponding Lake Erie elevation, suppose by proper controlling works at the head of the Niagara River the flow is increased to 220,000 cubic second-feet during 8 hours each day and reduced to 190,000 feet for 16 hours. Exactly the same amount of water is discharged from Lake Erie in the 24 hours, and no effect whatever appears on Lake Ontario. To accomplish this large increase of daylight discharge Lake Erie must be as high as elevation 573.1, and the controlling works must be designed to shut off 30,000 cubic second-feet, or 15 per cent. of the mean flow. Tentative figures indicate that a section of controlling gates from 400 to 500 feet in length will suffice to accomplish the change in flow desired.

16. The evolution of this simple method of nighttime

storage is interesting:

On page 76 of my report on the Preservation of

Niagara Falls is the following:

"The Falls are operative only as a scenic spectacle during the daylight hours. When the night shuts in partial depletion would not be scenically injurious. Such permits issue for half the flow of the river from sunset to sunrise, or for 12 or 16 hours every day, a tremendous power would become available that would furnish its own light, and factories might work by night instead of by day. The temporary lowering of the river would immediately readjust itself when the sunrise shutdown came. The interference with night navigation on the river would not be prohibitive in view of the benefits to be conferred in cheap power and light. The use of the night power at Niagara implies regulation of Lake Erie's outflow."

Maj. Charles Keller, of the Corps of Engineers, in commenting on my suggestion, states (p. 16, S. Doc. 105):

"As compensation for the restrictions necessarily im-

posed, the suggestion * * that the power companies be permitted to use half the flow of the river between sunset and sunrise is worthy of consideration. Many factories now run at night, and if the rate for power used between sunset and sunrise were made appreciably lower than the rate ruling during daylight hours, the amount of night use would probably increase. A further development of the storage battery might even render it commercially possible to use in the daytime the surplus power of the larger volume of night diversion. Such enlarged use of water at night, unless compensated, would result in a lowering of the level of Lake Erie. The necessary compensation works should, of course, be erected at the expense of the beneficiaries—the power companies."

The storage battery mentioned has its counterpart in the proposed storage of water in Lake Erie, for the purpose of making practicable the utilization of water according to the treaty with Great Britain, without diminishing too greatly the volume of flow on which the scenic grandeur largely depends. Instead of electric potential in the battery, the storage of water gives hydraulic po-

tential.

17. As to the regulation of Lake Erie, it is not purposed necessarily to lessen the amplitude of the yearly stage cycle, except in the avoidance of elevations below, say, 572.5 and above 574. The flow should be unrestricted during the months of January, February, March, and April to avoid low river levels. The gates may be continuously closed during November and December. During the months May to October, inclusive, storage by night with a river flow of 190,000 cubic second-feet and by day a heavy flow of 220,000 feet would be the normal condition.

18. No detailed analysis of the effect to be produced on Lake Ontario has been made. It should be understood, however, that the initial impounding to bring Erie to an annual mean elevation of 573.1 should be at a time of generous supply. The holdup of 10,000 cubic second-feet in November and December will raise Erie 0.3 feet and lower Ontario 0.4 feet. The increased flow of January to April will compensate these changes. In periods of scant supply, as in 1895-96, an adjustment between Erie

and Ontario would need to be made.

19. As regards Michigan-Huron, a betterment of Erie's level by 10 inches may lift these lakes 3 inches. Lake St. Clair would benefit to the extent of 6 inches or more.

20. The results to be obtained will be a betterment of conditions for the power companies, because the greater winter flow will lessen the difficulties coming from combinations of ice and low water. Nighttime storage will return to the daylight flow an amount of water equal to that permissible for the American side at Niagara Falls under the treaty with Great Britain. Navigation in Lake Ontario will not suffer substantially, and navigation in Lake Erie and above will be greatly improved.

FRANCIS C. SHENEHON.

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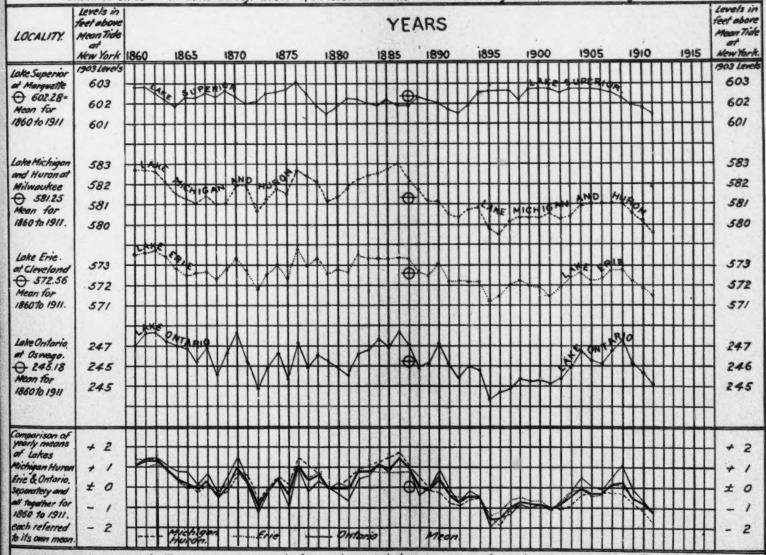
and

Plates 1-4 which appear in said report opposite p. 48.

SURFACE LEVELS OF THE GREAT LAKES

CURVES OF ANNUAL MEANS OF EACH LAKE FROM 1860 TO 1911.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers, Washington, D.C., November. 1911. Drawn in Office of U.S. Lake Survey. Based upon Records of the U.S Lake Survey and other U.S. Engineer Offices.



SURFACE LEVELS OF LAKE SUPERIOR AT MARQUETTE, MICH.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers. Washington, D.C., November, 1911.
Drawn in Office of U.S. Lake Survey. Based upon Records of the U.S. Lake Survey and other U.S. Engineer Offices.

Levels in feet			Cu	rve of	Annual	Mean	ns from	1860	to 191	I.			Levels in feet
referred to zero of gouge al Marquette.	YEARS. 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915									1915	referred to Mean Tide of New Yor (1903 levels)		
+ 3													604
+ 2													603
+1-	1			 				###	714				0 602
# 0						+1+-					1411	Ħ	
- / -											###	-	601
- 2													600

Zero of Marquette gauge = 601.75 above New York (U.S. Lake Survey level adjustment of 1903)
Mean level for 1876 or highest annual mean = 603.06, Highest monthly mean = 604.08. Sep. 1869.

" " 1879 lowest " = 601.43. Lowest " = 600.54. Apr. 1911.

" " Averages for 52 years or for 1860 to 1911 incl. = 602.28 (see in side columns)

Levels in feet referred to zero of gauge of Marquette	January	February	April	Moy	July	August	October	December	vecember.	Levels in feet- referred to Mean Tide of New York (1903 Jevels)
+3		I		I						605
+ 2	Н		Н	\perp	1	1				604
	Ц			1	1		1	1	A	603
400	び	1	建	E	I			1	9	0 602
	C	Ī		L	过	*	1	\	ç	601
	I	I			I			9		600

A - curve of 1876 or year of highest annual mean .

B. . . averages for 52 years, 1860 to 1911.

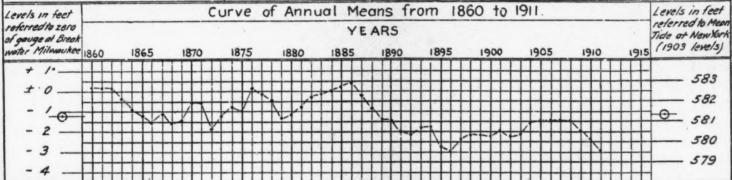
C - " 1879 or year of lowest annual mean.

O Represents the Average for 52 years, 1860 to 1911 incl. = 602.28.

APPENDIX A. PLATE 2. To accompany report of Board appointed by Secretary of War in S. O. 43. Office of Chief of Engineers, U.S. Army. Sept. 8.1910.

SURFACE LEVELS OF LAKE MICHIGAN AT MILWAUKEE WIS.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers, Washington, D.C., November. 1911 Drawn in Office of U.S. Lake Survey Based upon Records of the U.S. Lake Survey and other U.S. Engineer Offices.



Zero of Milwaukee gauge = 582.53 above New York (U.S.Lake Survey level adjustment of 1903)

Mean level for 1886 or highest annual mean = 582.96. Highest monthly mean = 583.57 June, 1886

" " 1896 - lowest " = 579.47 Lowest " = 578.98 Dec. 1895

" Averages for 52 years or for 1860 to 1911, incl = 581.25 (see 0 in side columns.)

Levels in feet referred to zero Of gauge at Breakwater Milwoykee.	January	February	Aoril	May	Levels in feet referred to Mea Tide at NewYork (1903 Jevels)						
+ 2 — + 1 — ± 0 — - 1 — - 2 — - 3 —	A -									A	584 583 582 581 580 580

A. curve of 1886 or year of highest annual mean .

B: .. averages for 52 years 1860 to 1911.

C. . . 1896 or year of lowest annual mean .

O Represents the Average for 52 years, 1860 to 1911. incl. - 581.25

APPENDIX A. PLATE 3. To accompany report of Board appointed by Secretary of War in S.O. \$43. Office of Chief of Engineers, U.S. Army Sept. 8.1910.

SURFACE LEVELS OF LAKE HURON AT HARBOR BEACH, MICH.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers, Washington, D.C., November, 1911.
Drawn in Office of U.S. Lake Survey, Based upon Records of the U.S. Lake Survey and other U.S. Engineer Offices.

Levels in feet			Curv	re of	Annual	Mean	s. from	1875	to 191	1.			Levels in feet
referred to zero of gauge at Harbor Beach.	1860	1865	1870	1875,	1880	YEA 1885		895	1900	1905	1910	1915	referred to Mean Tide at New York (1903 Levels).
+0 -						1							583 582
-2 -													0 581
-3								M					580 579

Zero of Horbor Beach gauge = 583.21 above New York (U.S. Lake Survey level adjustment of 1903)

Mean level for 1886 or highest annual mean = 583.08. Highest monthly mean = 583.66. July 1876.

" " 1896 or lowest " = 579.53. Lowest " = 579.02. Dec. 1895.

· Averages for 37 years or for 1875 to 1911 incl. = 581.14 (See -- in side columns.)

Levels in feet referred to zero of gauge at Harbor Beach.	January	April Moy June	referi Tide	Levels in teet referred to Mea Tide of New Yor (1903 Levels)		
+1	<i>B</i>				A	584 583 582 581 580 579

A = Curve of 1886 or year of highest annual mean

B = " Averages for 37 years, 1875 to 1911

C. . 1896 or year of lowest annual mean

O Represents the average for 37 years. 1875 to 1911 incl . 581 14.

APPENDIX A. PLATE 4. To accompany report of Board appointed by Secretary of War in S.O. \$43. Office of Chief of Engineers, U.S. Army. Sept. 8.1910.

SURFACE LEVELS OF LAKE ERIE. AT CLEVELAND. OHIO.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers. Washington, D.C., November, 1911.

Drawn in Office of U.S. Lake Survey. Based upon Records of the U.S. Lake Survey and other U.S. Engineer Offices.

Levels in feet	Curve of Annual Means from 1860 to 1911.												Levels in fee
referred to zero of gauge of Cleveland.	1860	1865	1870	1875	1880	1885	1890	1895	1900	1905	1910	1915	referred to Moo Tide at New Yor (1903 Levels)
+1													574
# 0-	1												573
-/-		74-77		MI			MI			7			572
-2			1111					NA					-
-3			++++										571
-4-			++++					###	####	###	++++	##	570

Zero of Cleveland Gauge 573.82 above New York (U. S. Lake Survey Levels of 1903.)

Mean Level for 1876 or Highest Annual Mean = 573.70. Highest Monthly Mean = 574.52 June.1876.

" " 1895 " Lowest " = 571.17. Lowest " 570.70 Nov. 1895.

" " Averages for 52 Years or for 1860 to 1911 incl. = 572.56 (see -in Side Columns.)

Levels in feet referred to zero of gauge at Cleveland	January	April	July	October	December	Levels in feet referred to Mea Tide at NewYork (1903 Levels)
+/	A A				A	575 574 573 572 571 570

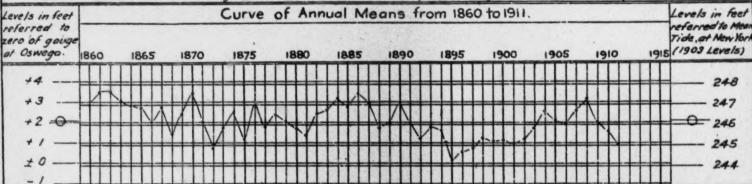
- A. Curve of 1876 or of highest annual mean .
- B: " Averages for 52 years 1860 1911.
- C: " 1895 or of lowest annual mean
- O Represents the Average for 52 years, 1860 to 1911 incl. = 572.56.

APPENDIX A. PLATE. 5. To accompany report of Board appointed by Secretary of War in S. O. 43. Office of Chief of Engineers, U.S. Army Sept 8-1910.

SURFACE LEVELS OF LAKE ONTARIO. AT OSWEGO, N. Y.

Under direction of Brigadier General W. H. BIXBY, Chief of Engineers, Washington, D. C., November. 1911.

Drawn in Office of U.S. Lake Survey, Based upon Records of the U.S., Lake Survey and other U.S. Engineer Offices.



Zero of Oswego Gauge 244-12 above New York (U.S. Lake Survey level Adjustment of 1903.)

Mean Level for 1862 or Highest Annual Mean = 247.63. Highest Monthly Mean = 248.95. May. 1870.

" " 1895 * Lowest " = 244.29. Lowest " = 243.41. Nov. 1895

" " Averages for 52 years or for 1860 to 1911 incl. = 246.18 (see-Q- in Side Columns.)

terels in feet referred to zero of gauge at Oswego.	January	February	April	May	June	August	September	October	December		Tide at	in feet d to Mean New York Levels.)
+5		+	7	4		\	4			+		249 248
+3	A B	7	/	1	ŧ		+	*		4	0	247 246
±0	c	+	/		*	/	+	†		6		245

A. Curve of 1862, or year of highest annual mean.

B . . Averages for 52 years, 1860 to 1911.

C = " 1895, or year of lowest annual mean.

-O Represents the Average for 52 years, 1860 to 1911 incl. = 246.18.

APPENDIX A. PLATE G. To accompany report of Board appointed by Secretary of War in S.O. * 43. Office of Chief of Engineers. U.S. Army. Sept. 8.1910.

House Doc. No. 762 ; 63d Cong., 2d Sess.

WAR DEPARTMENT. Nº 312. PART OF NIAGARA RIVER CHART#312. SCALE. PORT ERIE . N 943. PART OF ST.CLAIR RIVER CHART 443. SCALE.

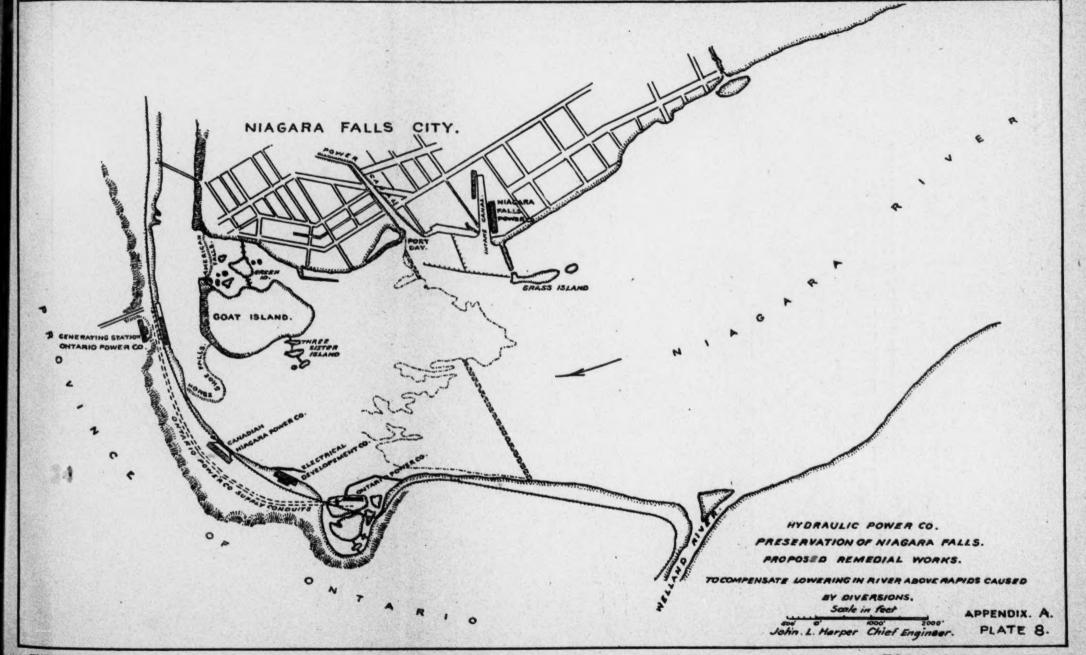
CORPS OF ENGINEERS, U.S. ARMY, Nº13. PART OF ST. LAWRENCE RIVER. CHART 13. SCALE.

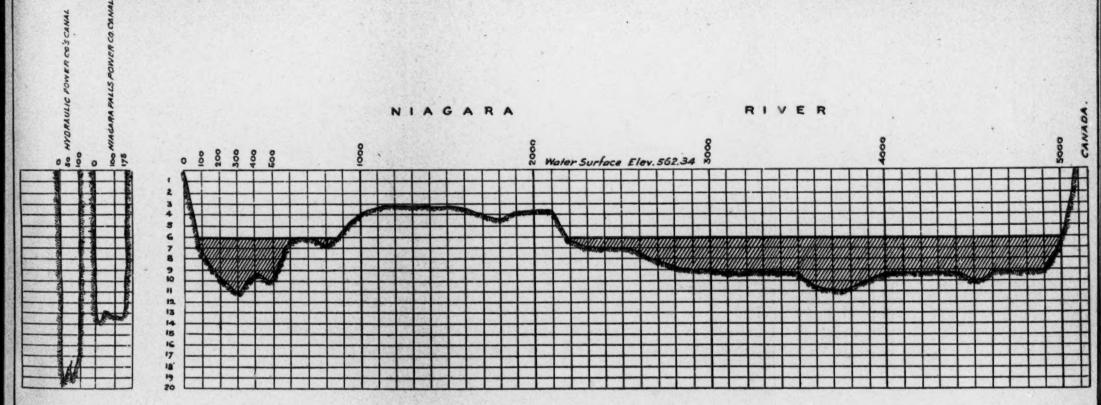
Extract's from U.S. Lake Survey Chart's Nois 13,-312, and 48 showing approximate locations of suggested compensation works.

To accompany Appendix A of Report of Board appointed by Secretary of War in S.O.43. Office of Chief of Engineers, U.S. Army. Sept. 8. 1910.

APPENDIX A PLATE. 7.

2643





Note Water surface Elevation 562.34 is equivalent to Lake Eric Elevation 573.26.

HYDRAULIC POWER CO.

CROSS-SECTION OF RIVER

BELOW PORT DAYAND CHIPPEWA.

SHOWING PROPOSED COMPENSATING WEIRS.

ALSO

CROSS-SECTION OF POWER CANAL

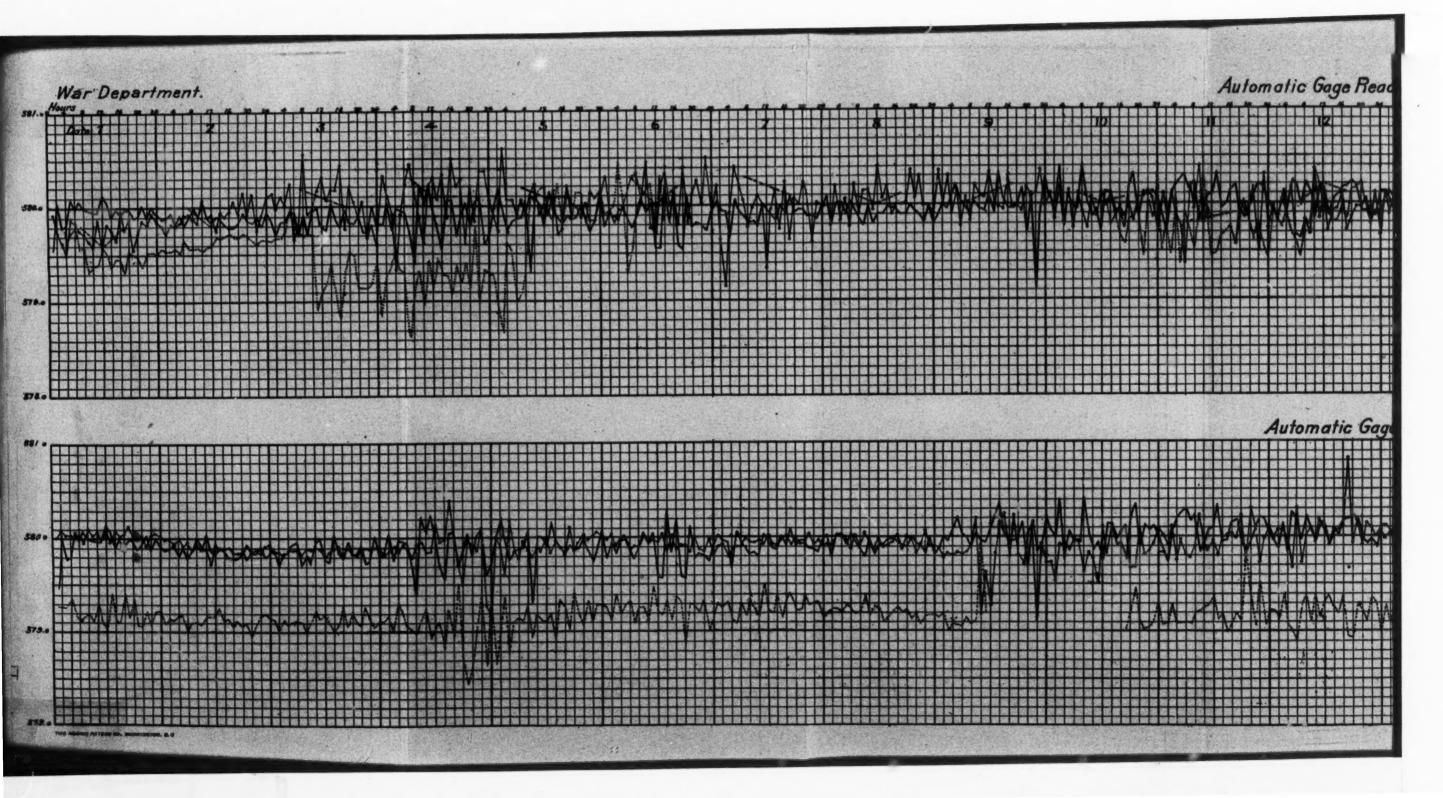
ON AMERICAN SIDE. HOR SCALE: /2 500' VERT. " " 8"

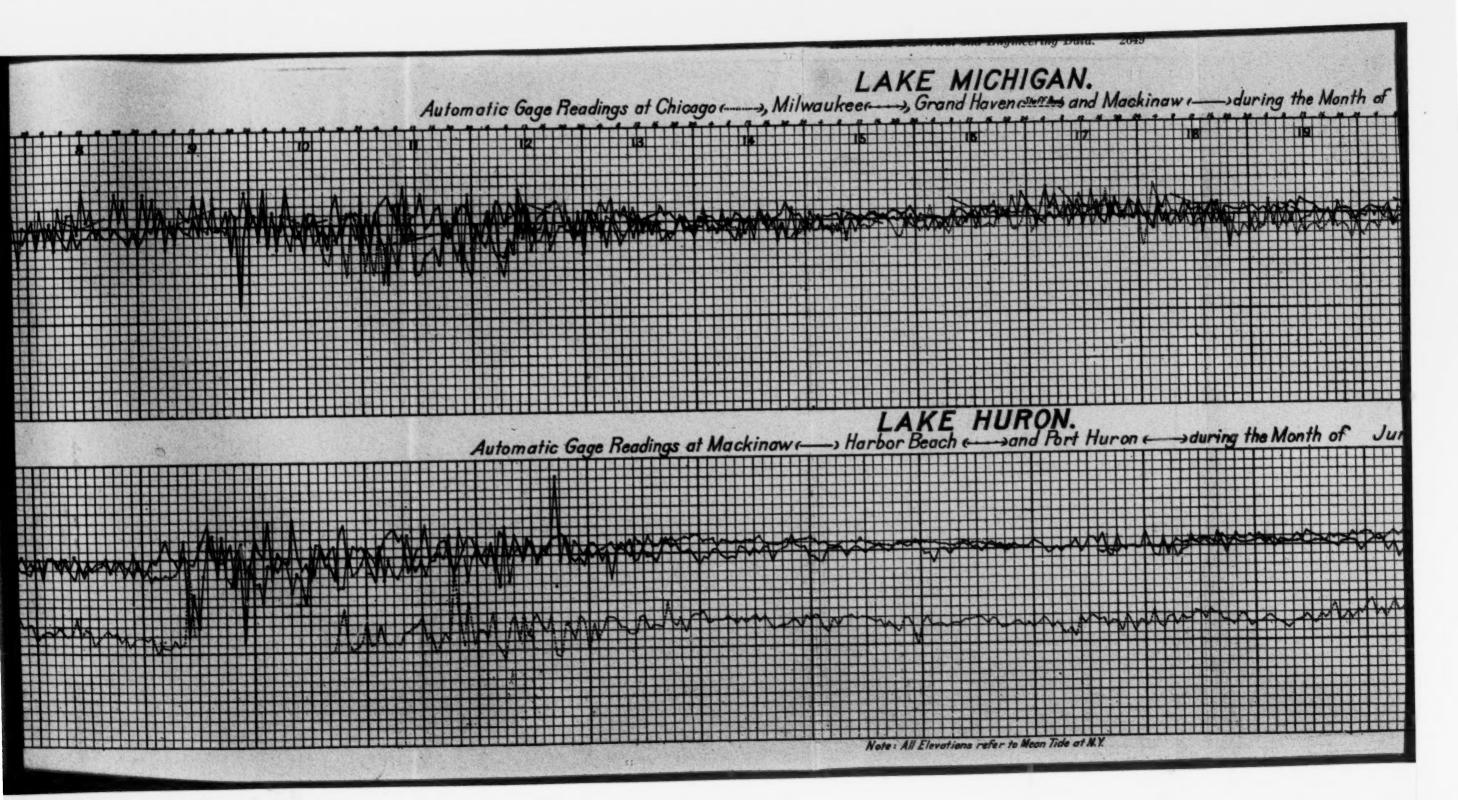
APPENDIX. A.

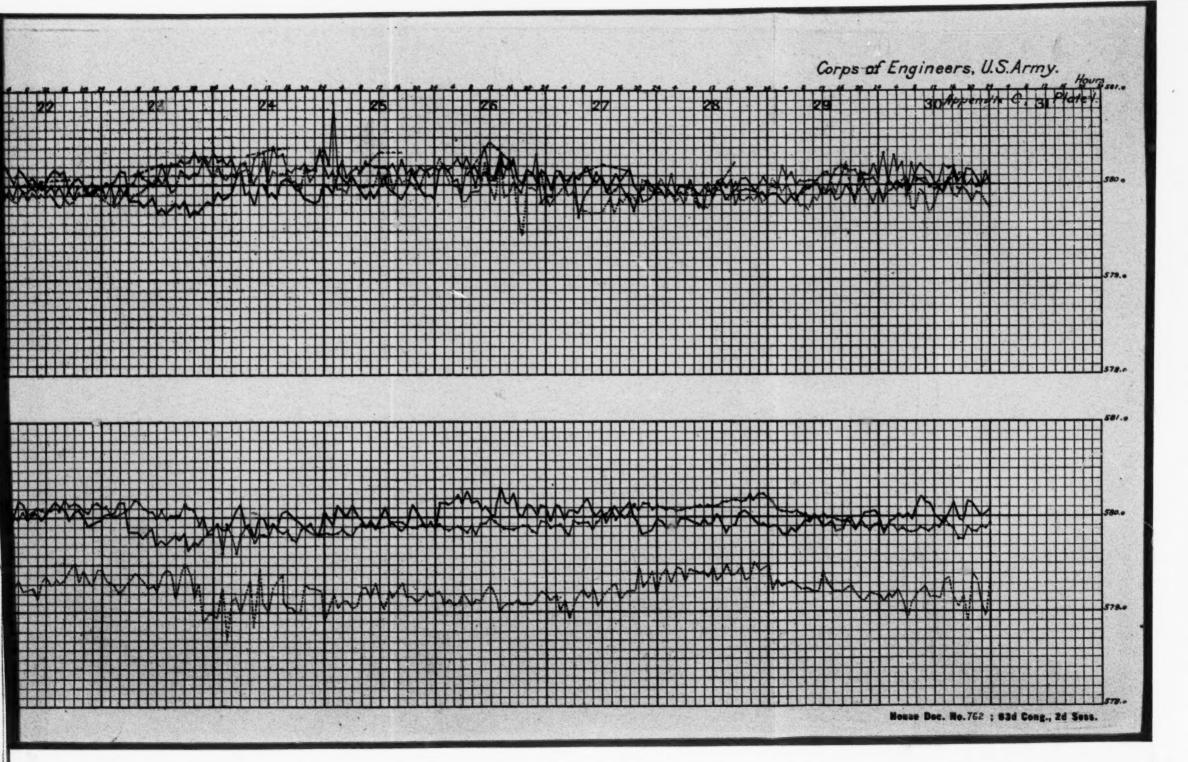
JOHN L.HARPER CHIEFENCINEER:

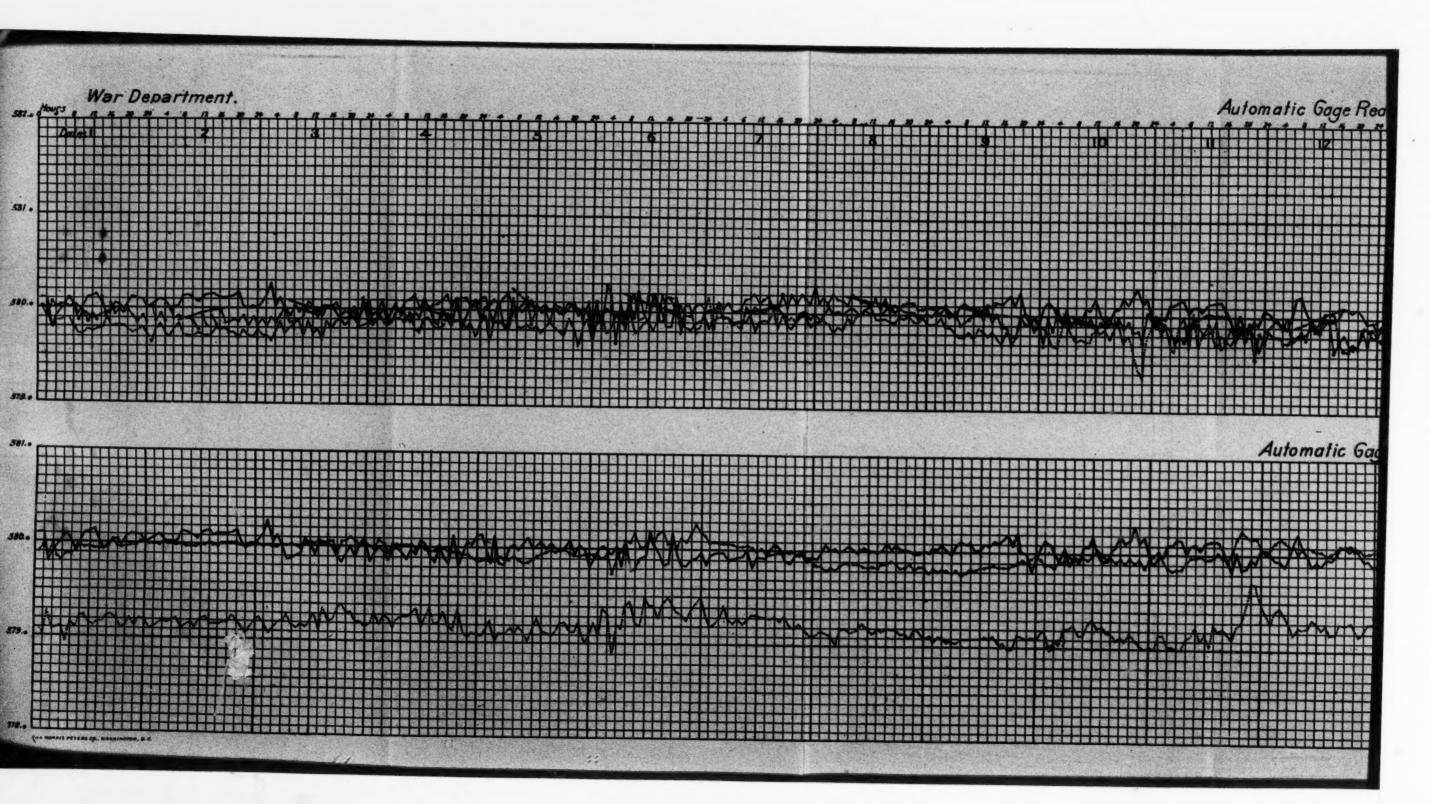
PLATE. 9.

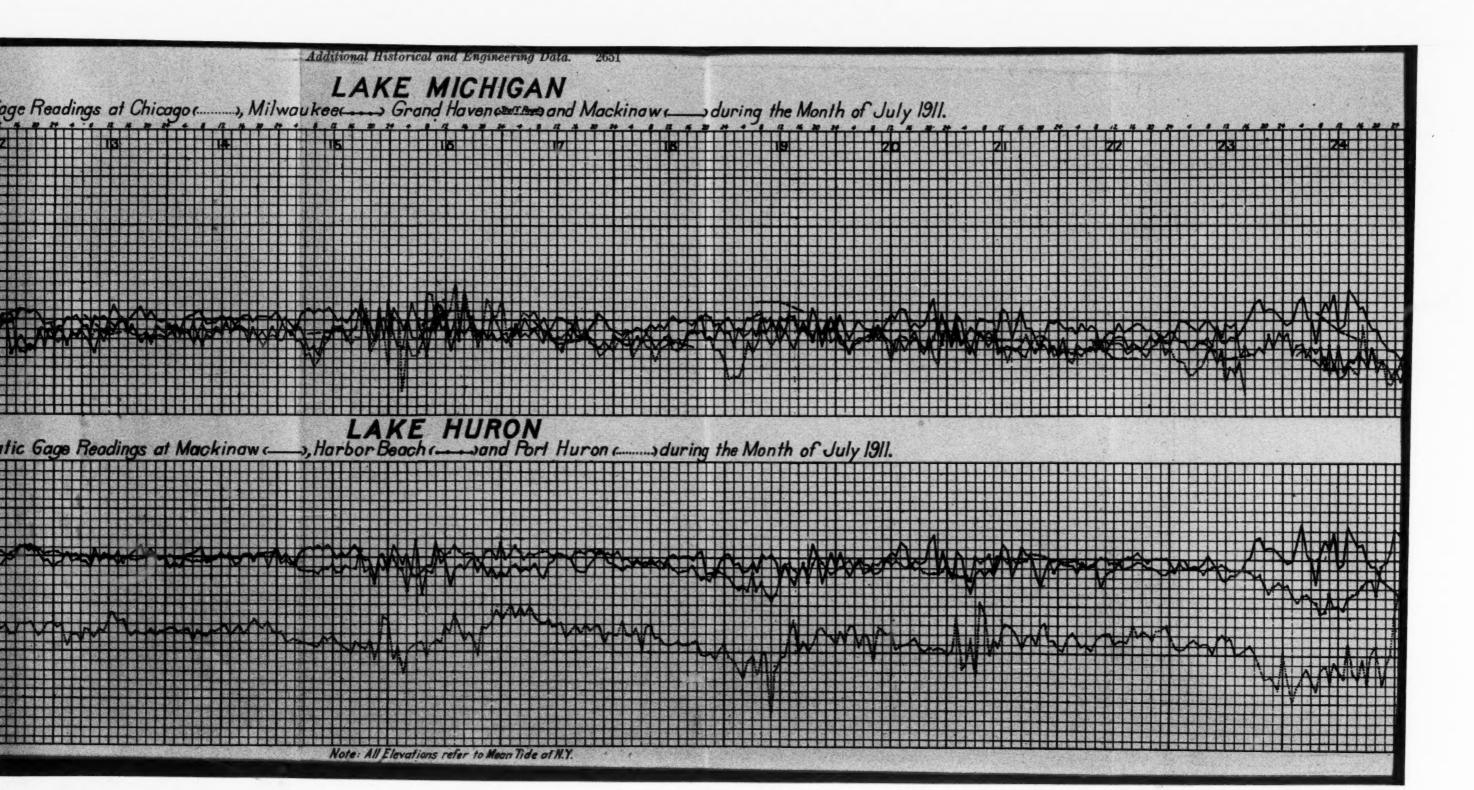
House Doc. No. 762 ; 63d Cong., 2d Sess.

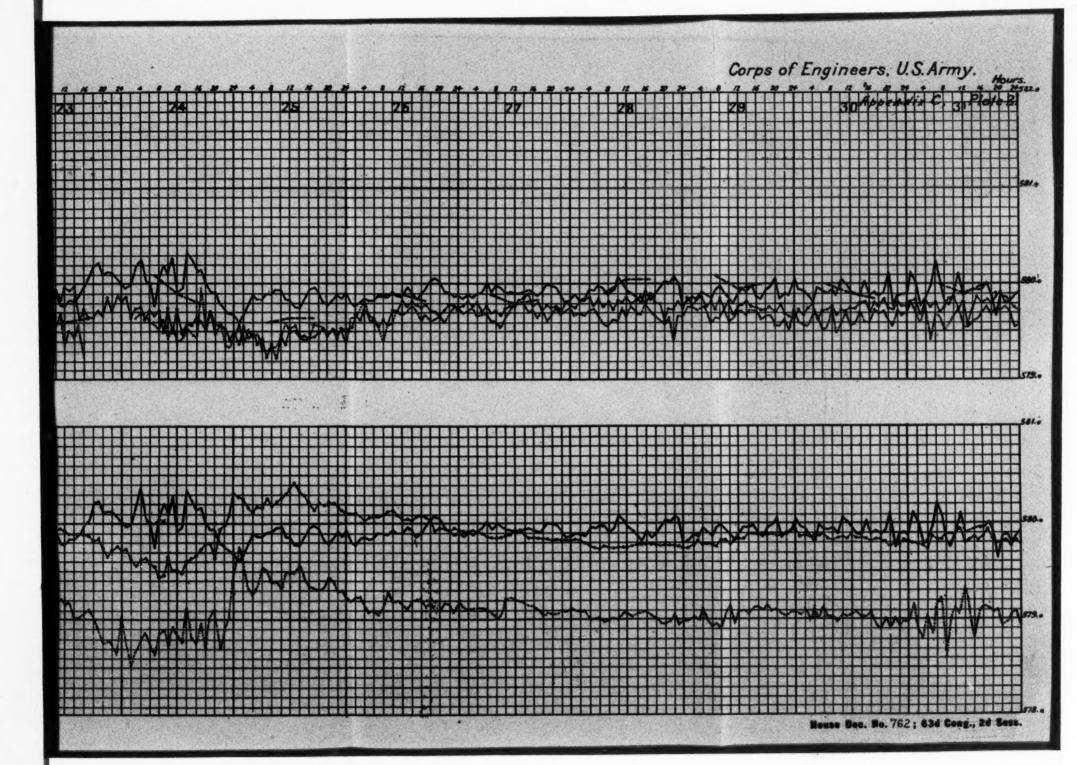


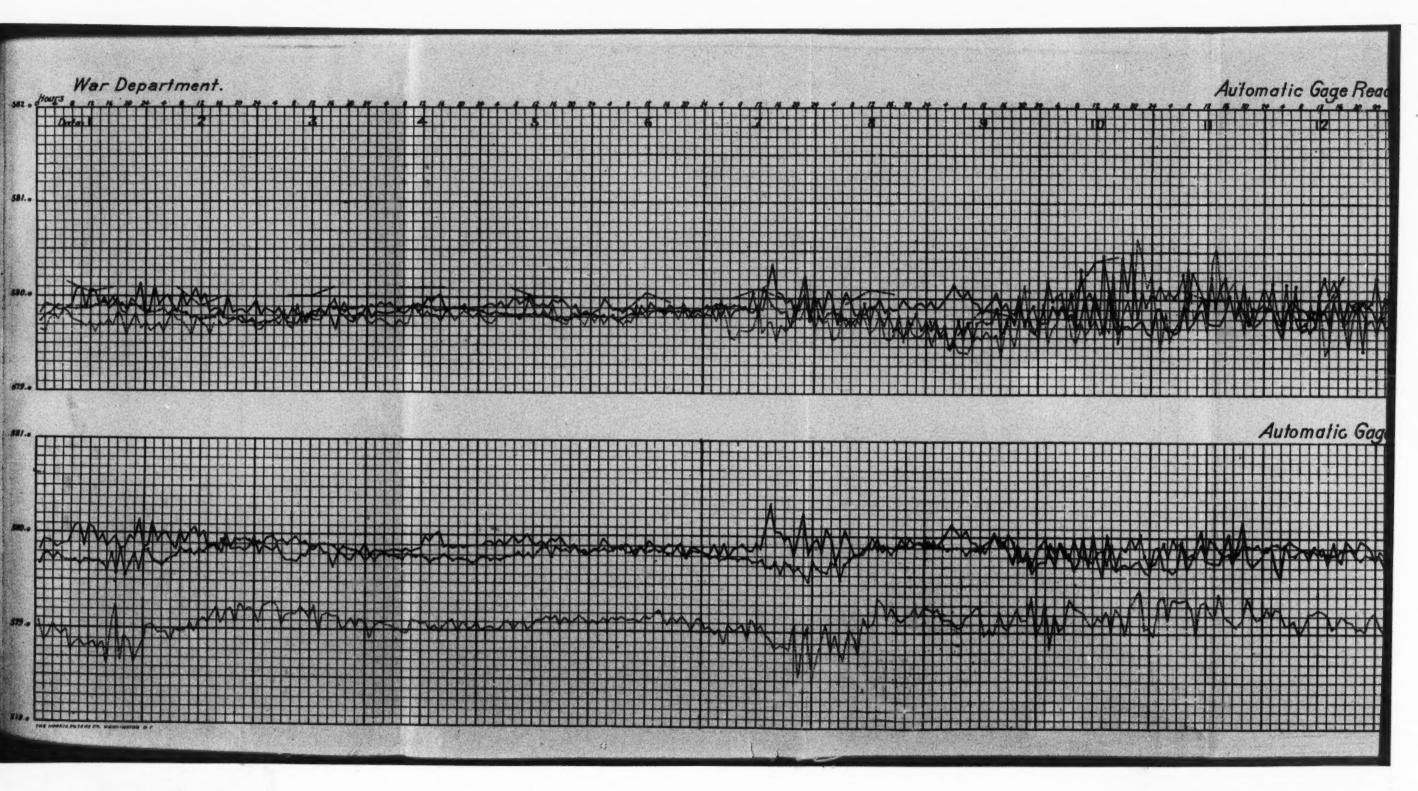


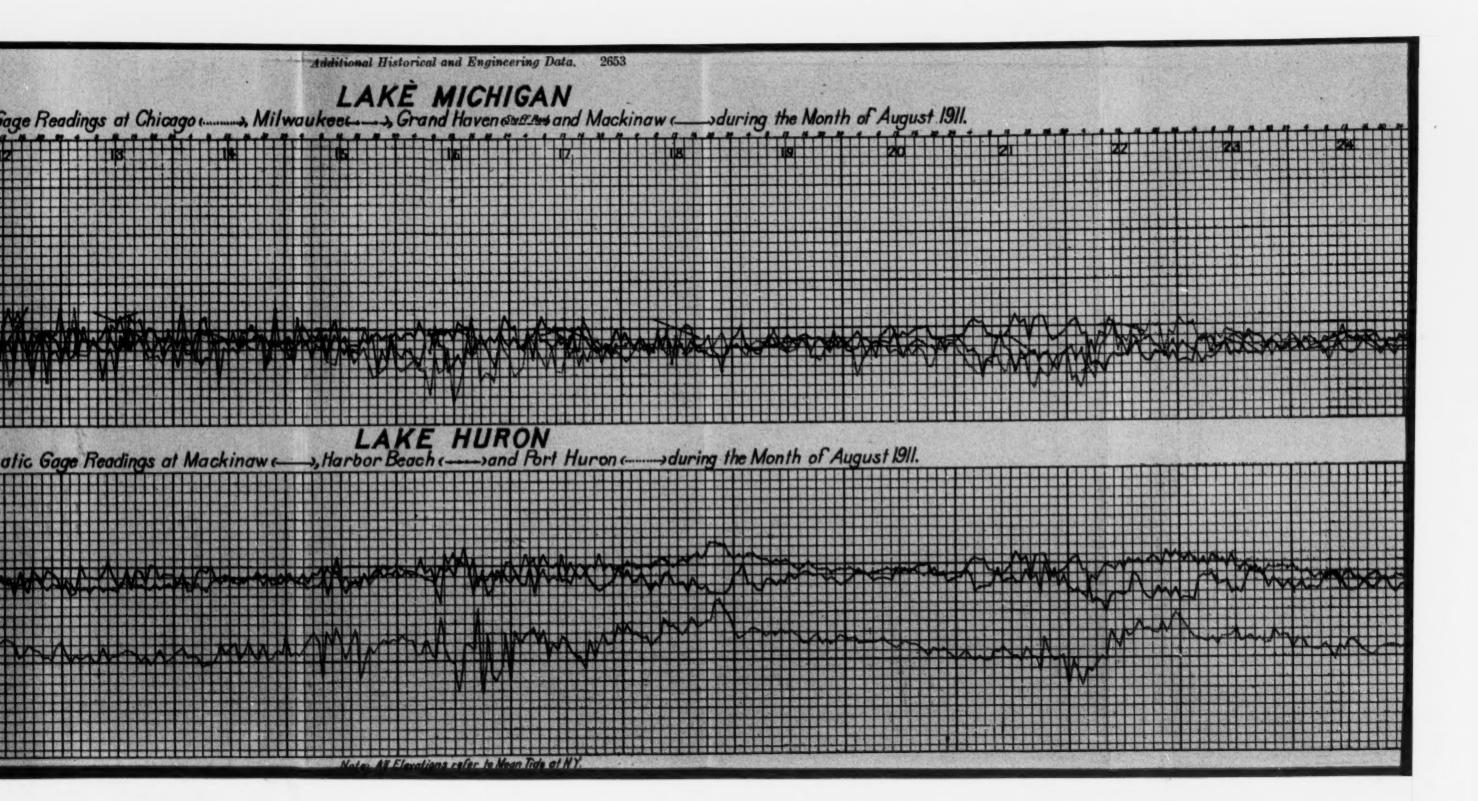


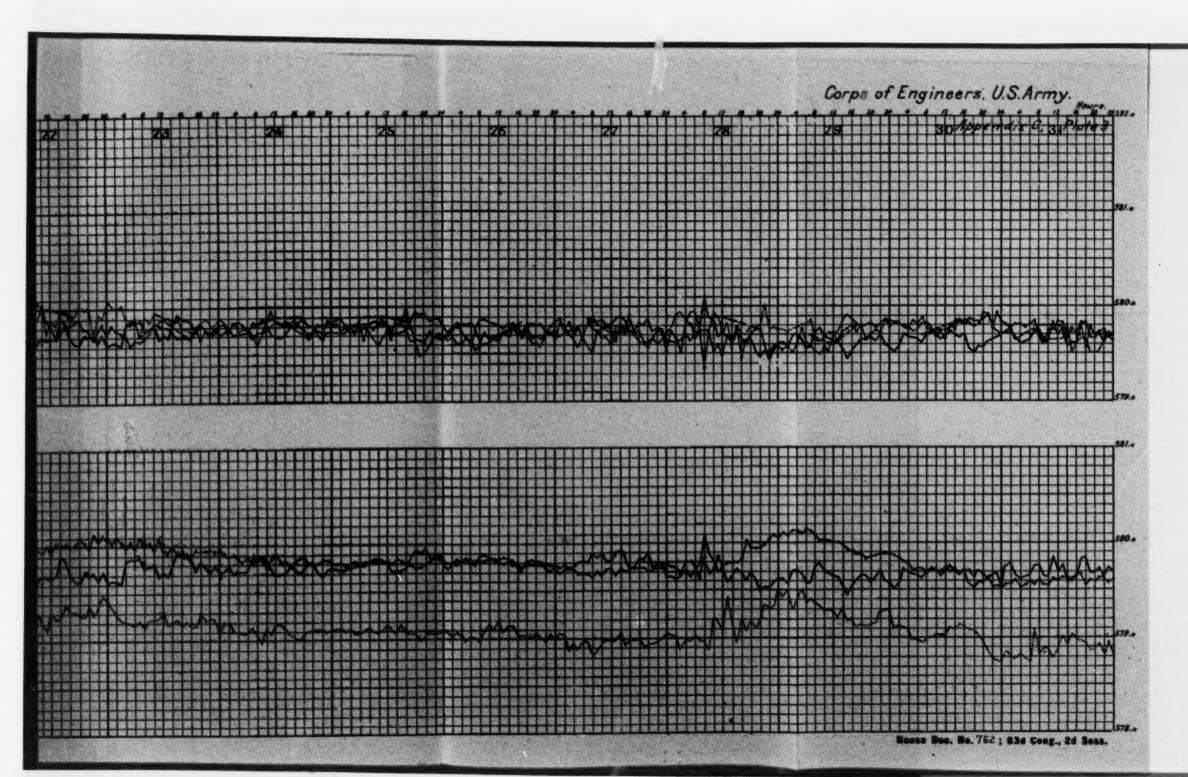


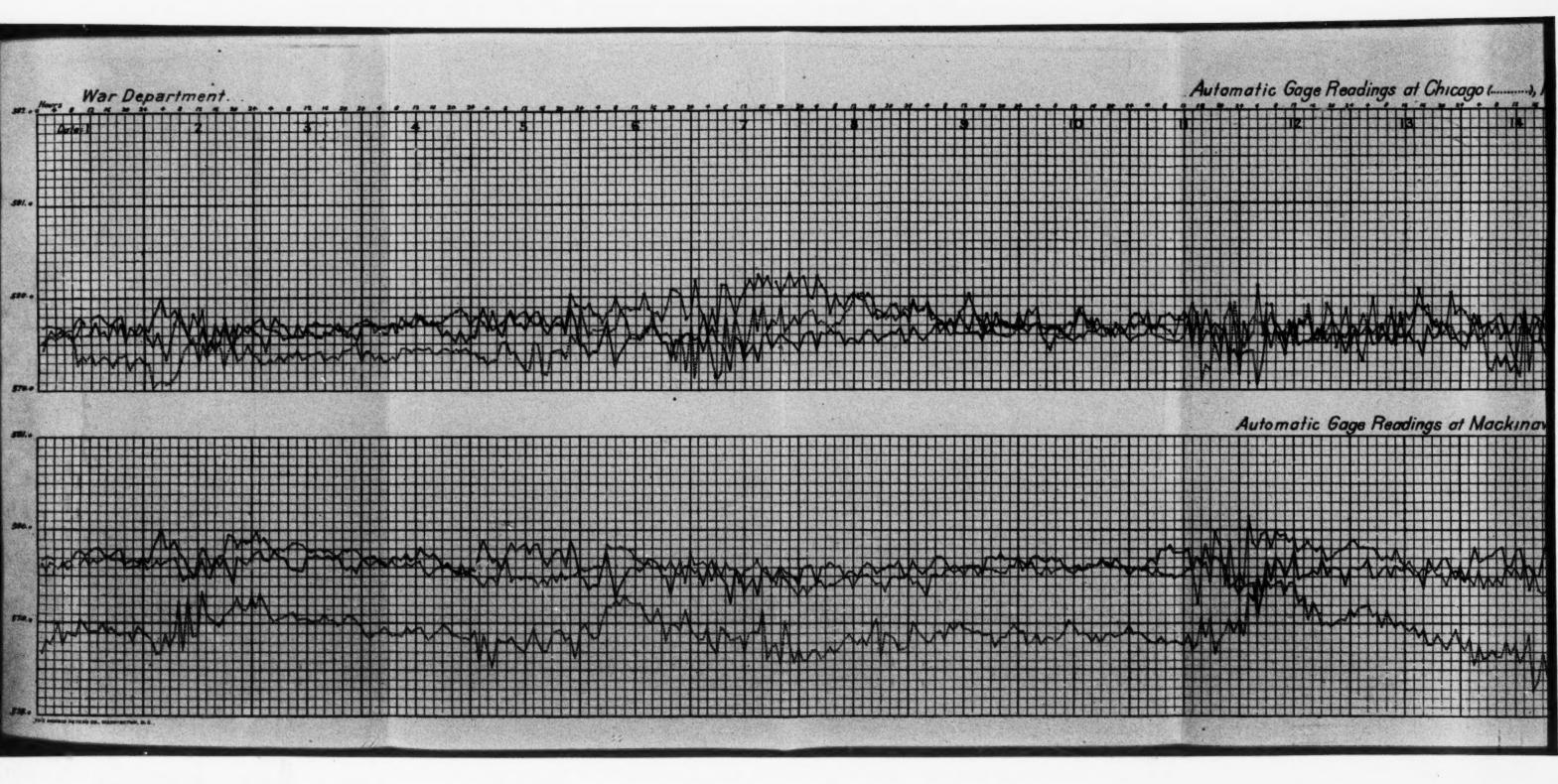


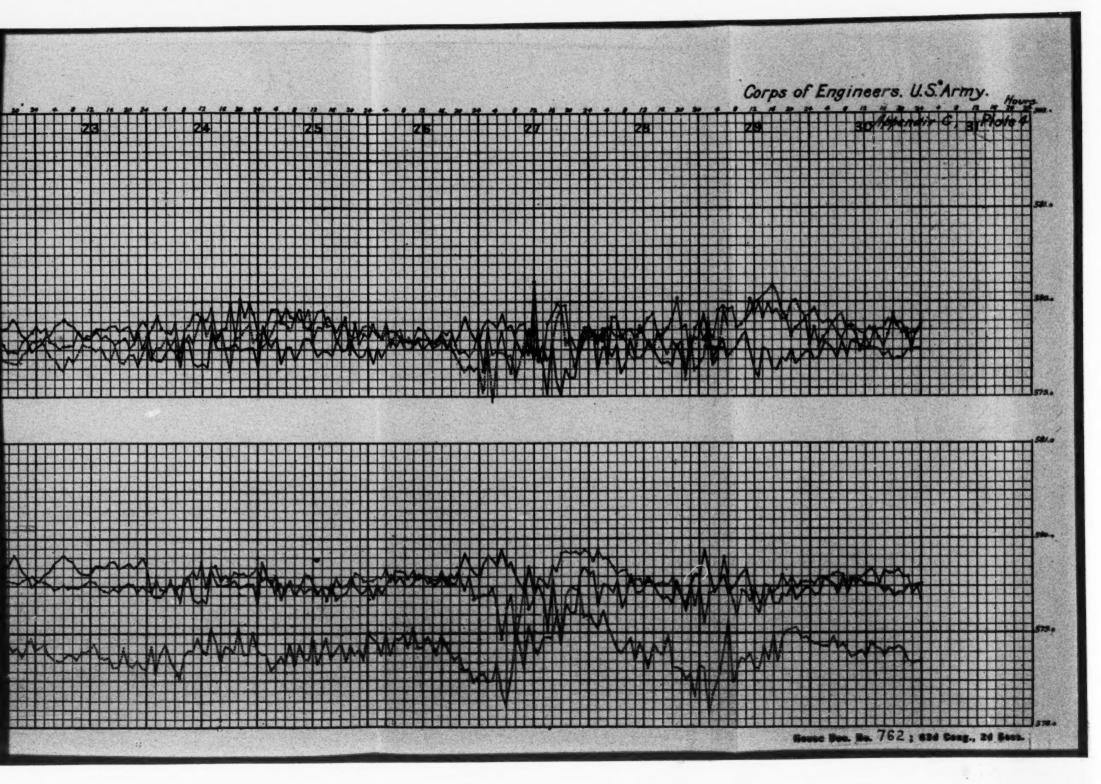












EXTRACT FROM THE STATEMENT OF THE SANITARY DISTRICT IN SUPPORT OF ITS APPLICATION FOR PERMISSION TO REVERSE THE CURRENT OF THE CALUMET RIVER, PENDING BEFORE HON. WM. H. TAFT, SECRETARY OF WAR, ON WHICH APPLICATION THE SECRETARY ACTED ON MARCH 14, 1907, APPEARING ON PAGES 8 AND 9 OF THE ANSWER OF THE SANITARY DISTRICT:

"While we are asking permission to thus reverse the flow of the Calumet River, we do not thereby concede that we have not the right to do so as a matter of right under the State law.

That while insisting upon the right as a matter of right, we are entitled, nevertheless to a permit from the Secretary of War to evidence that there exists between the two governments that 'spirit of harmony and conciliation' which, in the words of Chief Justice Marshall, in Gibbons v. Ogden, 'ought always to characterize the conduct of governments standing in the relation which that of the Union and those of the States bear to each other'; and to further evidence on the part of said governments that 'frank and candid co-operation for the general good' spoken of by Justice Johnson in the same case, 'which should always take place where there is a seeming blending of the power of the two governments and an apparent conflict.'

EXTRACT FROM STATEMENT OF SANITARY DISTRICT IN SUPPORT OF ITS APPLICATION FEBRUARY 5, 1912, TO HON. HENRY L. STIMSON, SECRETARY OF WAR FOR PERMISSION TO INCREASE THE AMOUNT OF WATER TO BE WITHDRAWN THROUGH THE MAIN CHANNEL OF THE SANITARY DISTRICT TO 10,000 CUBIC FEET PER SECOND UPON WHICH APPLICATION THE SECRETARY OF WAR RENDERED DECISION JANUARY 8, 1913, APPEARING ON PAGE 15 BILL OF COMPLAINT.

"While we are entitled to the use of the waters of Lake Michigan as a matter of right, we also believe that we are entitled to this permit from the Secretary of War, in order that there may be evidenced that 'spirit of harmony and concilliation which ought always to characterize the conduct of governments standing in the relation which that of the nation and those of the States bear to each other,' as expressed by Chief Justice Marshall in the case of Gibbons v. Ogden, 9 Wheaton, 1; and also to make manifest that which was referred to by Mr. Justice Johnson in the same case as that 'frank and candid co-operation for the general good which should always take place where there is a seeming blending of the power of the two governments, and an apparent conflict."

ENS